HHL LEIPZIG GRADUATE SCHOOL OF MANAGEMENT

Dissertation

Analytical and Empirical Analyses on Fixed Asset Write-Offs

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Abstract:
The objective of the International Financial Reporting Standards (IFRS) is to provide useful information to the users of financial statements to assist in making economic decisions. To be useful, information has to be relevant and reliable, but the reliability of information suffers when the guidelines for the reporting of specific issues are not clear and managerial discretion arises. Write-offs are one of those accounting issues that are regularly related to earnings management. By now it is seen as common knowledge that write-offs, especially those on goodwill, do not reflect declines in asset value; rather, they are used as a device to manipulate financial reports. However, there is a striking lack of grounded theoretical research that can confirm this assessment. The aim of this dissertation is to provide valuable analytical and empirical insights on fixed asset write-offs under IFRS. In a first step, the practical implementation of IAS 36 in Europe has to be analyzed, which is best done empirically. Based on the findings from these empirical surveys, the most substantial questions remaining are subject to an in-depth analytical discussion. Since IAS 36 entails different measurement issues that have their origins in finance theory, this dissertation also aims to introduce some basic techniques from theoretical finance to accounting research. Lastly, as the analyses presented in this dissertation do not cover all open questions on fixed asset write-offs, the author hopes to encourage further research on this important topic.

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1 Analytical and Empirical Analyses on Fixed Asset Write-Offs: An Overview

Chapter contents

1.1 Introduction

The objective of the *International Financial Reporting Standards* (IFRS) is to provide useful information to the users of financial statements to assist in making economic decisions.[1] To be useful, information has to be relevant and reliable, but the reliability of information suffers when the guidelines for the reporting of specific issues are not clear and managerial discretion arises.

Write-offs are one of those accounting issues that are regularly related to earnings management. By now it is seen as common knowledge that write-offs, especially those on goodwill, do not reflect declines in asset value; rather, they are used as a device to manipulate financial reports.[2] However, there is a striking lack of grounded theoretical research that can confirm this assessment.

Indeed, several of the requirements incorporated in IAS 36 *Impairment of Assets* entail managerial discretion. Implementing an impairment test necessitates the calculation of the recoverable amount of the asset under consideration, which is defined as the higher value of the fair value less costs to sell and the value in use. The fair value less costs to sell is to be derived from an active market – which is in practice absent for most assets. The value in use is to be calculated from corporate planning, discounting the cash flows from further internal use and the disposal of the asset with a discount rate that reflects market perceptions. Both estimating the fair value less costs to sell if there is no market price and calculating the value in use introduce material room for managerial discretion.

Some of this managerial discretion could be eliminated by a rigorous analytical dis-

[1] See paragraph 12 of the IFRS Framework.

[2] A recent survey by the *European Securities and Markets Authority* (ESMA) found that write-offs on goodwill and other intangible assets do not seem to reflect the effects of the financial and economic crises appropriately, see *ESMA* (2013).

cussion of the rules presented by IAS 36. In particular, the definition of the value in use urgently needs further elaboration. IAS 36 requires a pre-tax calculation, but a theoretically suitable model to fulfill this requirement has not yet been designed. Moreover, analytical discussion related to asset write-offs is scarce. While there is an extensive debate regarding the depreciation-problem[3], write-offs remain virtually disregarded.[4]

A number of empirical studies regarding the determinants of fixed asset write-offs have been conducted for the US market.[5] Under different regulations regarding the accounting for fixed asset write-offs, these studies find very different determinants of the write-off decision. Some research has been done regarding the Australian market,[6] but only very limited work has been done on Europe.[7] As different regulations apply in Europe and because the influence of national patterns on the write-off tendency is hard to measure,[8] the findings of existing research are not necessarily applicable to European companies.

Furthermore, while empirical studies find that earnings management as well as declines in asset values are important determinants of asset write-offs, they cannot answer the question as to the circumstances under which earnings management is applied.

The aim of this dissertation is to provide valuable analytical and empirical insights on

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[3]The depreciation problem describes the question of how much of an asset should be depreciated on a regular basis; see, for example, *Jackson* (1911), *Wright* (1964) or *Kim* and *Moore* (1988).

[4]*Goex* and *Wagenhofer* (2009) analyze the optimal impairment rules in a game theoretical setting, and there is an ongoing debate on the appropriate discount rate for the calculation of the value in use (see *Husmann* and *Schmidt* (2008), *Kvaal* (2010) and *Husmann* and *Schmidt* (2011)), but none of these studies answer the question of how the rules should be implemented.

[5]See, for example, *Zucca* and *Campbell* (1992) for an analysis of write-offs in the absence of respective regulations, *Riedl* (2004) for an analysis of asset write-offs under SFAS 121 *Accounting for the Impairment of Long-Lived Assets*, and *Beatty* and *Weber* (2006) for an analysis of asset write-offs in the SFAS 142 *Goodwill and Other Intangible Assets* adoption period.

[6]See, for example, *Minnick* (2011).

[7]*AbuGhazaleh*, *Al-Hares* and *Roberts* (2011) analyze goodwill write-offs in the United Kingdom.

[8]See *Kvaal* and *Nobes* (2012).

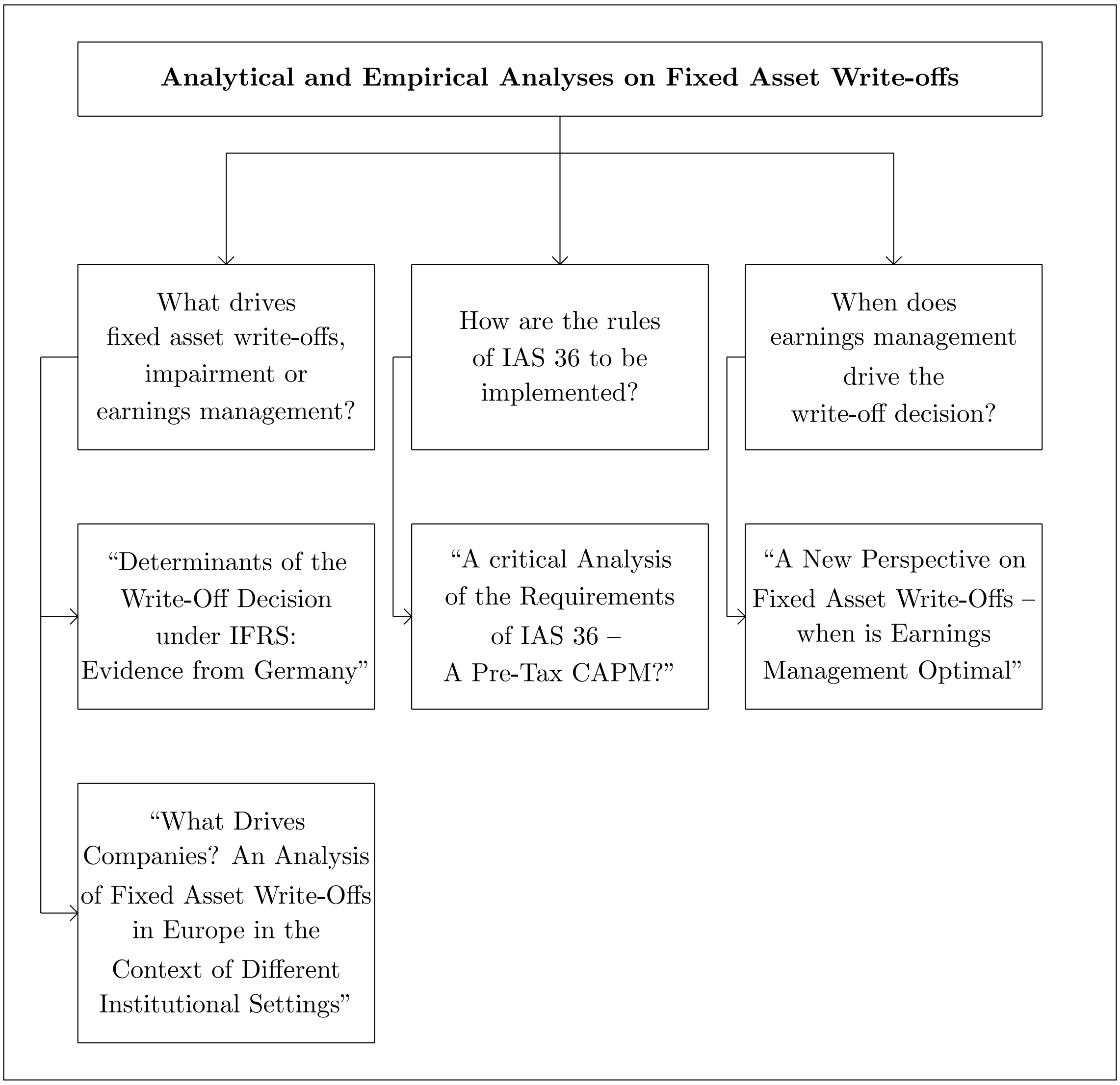
fixed asset write-offs under IFRS. In a first step, the practical implementation of IAS 36 in Europe has to be analyzed, which is best done empirically. Based on the findings from these empirical surveys, the most substantial questions remaining are subject to an in-depth analytical discussion. Since IAS 36 entails different measurement issues that have their origins in finance theory, this dissertation also aims to introduce some basic techniques from theoretical finance to accounting research. Lastly, as the analyses presented in this dissertation do not cover all open questions on fixed asset write-offs, the author hopes to encourage further research on this important topic.

As depicted in Figure 1.1, the dissertation answers three main research questions. The first research question is "What drives fixed asset write-offs, impairment or earnings management?". This question is addressed empirically by the two papers "Determinants of the Write-Off Decision under IFRS: Evidence from Germany" and "What Drives Companies? An Analysis of Fixed Asset Write-Offs in Europe in the Context of Different Institutional Settings". The second research question – "How are the rules of IAS 36 to be implemented?" – is addressed by the analytical paper "A Critical Analysis of the Requirements of IAS 36 – A Pre-Tax CAPM?". The last research question – "When does earnings management drive the write-off decision?" – is answered in the analytical paper "A New Perspective on Fixed Asset Write-Offs – When is Earnings Management Optimal".

1.2 Overview of the Manuscripts

This dissertation contains four manuscripts that discuss very specific issues related to fixed asset write-offs according to IAS 36. The basics of IAS 36 and the main problems regarding its practical implementation are discussed in the paper "Der Impairment-Test gemäß IAS 36: Problembereiche und Implikationen der Wirtschaftskrise", published

Figure 1.1: Structure of the dissertation manuscripts



in the journal IRZ in 2010,[9] and the CFRC Note "Accounting for the Impairment of Assets under IFRS".[10]

[9]See *Siggelkow* and *Zülch* (2010).
[10]See *Siggelkow* and *Zülch* (2011).

The first paper in this dissertation – "Determinants of the Write-Off Decision under IFRS: Evidence from Germany" – empirically analyzes the factors that drive the write-off decisions of German listed companies. As outlined above, as yet no empirical study regarding write-offs in Germany has been conducted. The findings of existing studies in different markets may not hold for German companies since they have to apply differing accounting rules and operate in a very different institutional setting. The aim of this paper is to close this research gap and identify the drivers of write-offs in Germany.

To reach this goal, a sample of 165 German firms that were listed in the DAX, MDAX, TecDax and SDAX indices between 2004 and 2010, comprising 805 firm-years, is analyzed. As the write-off decision is a bivariate variable, a probit model is applied. Three groups of independent variables are included in the analysis. The first group contains variables measuring the firm performance and is supposed to proxy for the probability that the firm has impaired assets. The second group of variables identifies firm-years in which incentives for earnings management are expected to arise. Finally, the third group comprises other variables that have previously been shown to have an influence on write-offs.

This structure enables analysis of the general hypothesis that write-offs are driven by both asset impairment and earnings management. The findings of the study support this hypothesis as both factors are shown to be important determinants of the write-off decision. The most significant result is that write-offs seem to be used to smooth income.

The findings imply that the write-off behavior of German companies materially differs from that of US companies, as big bath accounting and management changes have regularly been found to be significant drivers for the write-offs of the latter.[11] None of these factors seems to have a significant influence in Germany. This difference could derive either from the different accounting standards applied or from the different institutional setting that companies operate in.

Additionally, these findings imply that the reporting of fixed asset write-offs is distorted. The fact that income smoothing is applied means that the information content of financial reports is reduced. Write-offs have been one of the main focus areas of the *Financial Reporting Enforcement Panel* (FREP) since 2006.[12] The findings of this study indicate that write-offs are still used for earnings management, and that further actions are necessary to ensure the provision of useful information regarding the value of fixed assets.

This paper has been accepted for publication in the journal *International Business & Economics Research*. The study is co-authored by Henning Zülch. The input of the submitting doctoral candidate includes the development of the research question, the preparation of the theoretical and empirical basis, the gathering of data and the execution of empirical analyses as well as the respective interpretation and the issuance of the draft paper. An earlier version of the paper was presented at the annual European Accounting Association Conference 2011 in Rome. Furthermore, it was accepted for presentation at the annual meeting of the American Accounting Association 2011 in Denver, and at the Workshop on Empirical Research in Financial Accounting 2011 at the University of Seville. Additionally, the most important implications for the users of financial statements have been discussed in the article "Bilanzpolitik im Rahmen der Entscheidung zur Erfassung einer Wertminderung gemäß IAS 36 - Empirische Analyse

[11] See for example *Riedl* (2004) or *Beatty* and *Weber* (2006).
[12] The main focus areas of the FREP can be inspected at `http://www.frep.info/pruefverfahren/pruefungsschwerpunkte_en.php`.

des Bilanzierungsverhaltens deutscher Unternehmen im Zeitraum 2004 - 2010" which was published in the journal *Corporate Finance biz* in 2012.[13]

In the second manuscript – "What Drives Companies? An Analysis of Fixed Asset Write-Offs in Europe in the Context of Different Institutional Settings" – the drivers of the write-off decision and the respective magnitude of companies from the EU15 member states are analyzed. The contribution of this analysis to the write-off research is threefold. First, as outlined above, empirical analyses regarding write-offs in Europe are very scarce, and no study analyzing all European countries has been conducted to date. Second, a methodological contribution is made by introducing a double hurdle model to the analysis of write-offs, which is suited to simultaneous analysis of the drivers of the write-off decision and the write-off magnitude. In previous research the Tobit model has mostly been applied. The Cragg model, applied in this paper, has the advantage of allowing for different influences at both stages of the determination of write-offs, whereas for each determinant the Tobit model implies the same influence on the write-off decision as on the write-off magnitude. Finally, to the best of the author's knowledge, no study covering a comparable number of countries has yet been conducted. Therefore, this study is the first to provide empirical insight on the influence of institutional settings on the write-off decision. The aim of this paper is to gain an understanding of the mechanisms involved in the determination of write-offs and to analyze the impact of asset impairment, earnings management and institutional factors.

The sample used for this analysis comprises 1,300 companies and a total of 7,268 firm-year observations of companies that are domiciled in the EU15 member states. It covers the period from 2005 to 2011. As stated above, the Cragg model is applied.

[13]See *Siggelkow* and *Zülch* (2012).

This model analyzes the write-off decision as a bivariate variable at the first stage, and the write-off magnitude as a logarithmized ratio of the write-off to the previous year total assets at the second stage. As independent variables, basically the same groups as for the analysis of the German setting are applied: a group of variables measuring firm performance to proxy for the probability that the firm holds impaired assets, a group of variables identifying periods that suggest earnings management, and a group of control variables that measure those effects that have previously been shown to influence write-offs. Building on the findings of the first analysis comprising firms from all countries, three country clusters developed by *Leuz*, *Nanda* and *Wysocki* (2003) are used to classify the companies involved and analyze differences in the mechanisms that drive write-offs.

The general hypothesis of this paper, as for the German setting, is that write-offs are driven by asset impairment as well as by earnings management. Additionally, it is assumed that the drivers of write-offs vary based on the institutional setting within which the company operates. The findings of the study support the hypotheses. It is found that while the decision to recognize a write-off is mainly driven by asset impairment, the decision regarding the amount that is written off is materially influenced by earnings management as well. In particular, support for big bath accounting and income smoothing is found. Regarding the country clusters, the results of the study indicate that there are different drivers of fixed asset write-offs; the most significant result indicates that the write-off magnitude is used for earnings management in countries with high investor protection.

There are two important implications of these findings. First, they support the assessment that in European countries applying IAS 36, write-offs do not exclusively reflect economic declines in asset values; rather, they are used to manage earnings. Second, they show that the harmonization which was the intended result of the mandatory adoption of the IFRS in Europe has not yet been reached. On the contrary, the findings support the statement by *Ball* (2006), that the mere implementation of uniform accounting standards is not sufficient to ensure uniform accounting practices. An additional analysis regarding the changes of those mechanisms that drive write-offs over time further supports *Schipper* (2005) in stating that a uniform enforcement body is needed to reach uniform accounting practices.

This paper has been submitted for publication to the *European Accounting Review*. Additionally, the paper has been published as an HHL Working Paper.[14] Furthermore, the paper has been accepted for presentation at the annual European Accounting Association (EAA) Conference 2013 in Paris. The co-author is Henning Zülch. The contribution of the author of this dissertation is in the development of the research question, the required database and the theoretical and empirical foundations, the execution of the empirical analyses and the preparation of the draft manuscript. The most important practical implications of the research findings were merged into the paper "Bilanzpolitik bei Wertminderungen europäischer Unternehmen - eine empirische Analyse", which has been submitted to the journal *Betriebswirtschaftliche Forschung und Praxis*.

The third paper – "A Critical Analysis of the Requirements of IAS 36 – A Pre-Tax CAPM?" analyzes the requirements of IAS 36 regarding the derivation of the discount rate for the calculation of the value in use. While there has been a discussion regarding the reasonableness of those requirements,[15] the contribution of this paper is a detailed discussion of their practicality.

IAS 36 requires the use of a pre-tax discount rate that is independent of the capital

[14] See *Siggelkow* and *Zülch* (2013). This paper is also available at `http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2198809`.

[15] See *Husmann* and *Schmidt* (2008), *Kvaal* (2010) and *Husmann* and *Schmidt* (2011).

structure. However, in practice the *weighted average cost of capital* (WACC) are usually used,[16] a measure which fulfills none of these requirements. This ignorance of the statutory provisions can be ascribed to a lag in terms of guidance on how they could be fulfilled. There is no theoretical model that allows calculation of the pre-tax cost of capital, and neither is there a consistent recommendation for how the influences of the capital structure should be eliminated from the cost of capital.

Therefore, the objectives of this paper are to explicitly elaborate the requirements of IAS 36 regarding the discount rate to be deployed to calculate the value in use, contrasting these requirements with the existing recommendations and techniques used in the practical application, and finally deriving a model that is theoretically fulfilling all of the identified requirements.

The result of this paper is a variation of the classical *capital asset pricing model* (CAPM), which incorporates taxes on the firm level. It is noted that independence of the capital structure can be achieved by deploying the cost of equity of the fictitiously unlevered firm. If these costs of equity were calculated based on the model derived in this paper, all of IAS 36's requirements could be fulfilled. However, the model has some important problems in terms of its application, leading to the conclusion that the *International Accounting Standards Board* (IASB) should revise the rules regarding the calculation of the value in use.

The results of this paper imply that it is currently not possible to calculate a value in use that truly fulfills all the requirements of IAS 36. While there exists some practical guidance that tries to consider all these requirements, a theoretically convincing solution does not exist; the specifications of IAS 36 are inconsistent to a very high degree, requiring further analytical discussion to find an appropriate solution. This paper is a

[16] See *KPMG* (2010).

first step in reaching this goal.

This paper is under review for publication by the journal *Zeitschrift für Betriebswirtschaft*. It is co-authored by Marcus Salewski and Henning Zülch. The contribution of the submitting doctoral candidate lies in the development of the research question and the theoretical basics regarding IAS 36, and in cooperation in deriving the model and the interpretation. Additionally, the author of this dissertation independently translated the paper into English and revised it to incorporate commentaries received from referees. An earlier version of this paper in German has been published as an HHL Research Paper,[17] and presented at the 6th Research Forum at HHL Leipzig Graduate School of Management.

The fourth paper – "A New Perspective on Fixed Asset Write-Offs – When is Earnings Management Optimal" – contains an analysis of the question of when it is optimal to opportunistically delay a write-off and under which circumstances immediate recognition is the optimal strategy. While this question results from the findings of empirical studies on the determinants of fixed asset write-offs, it has never been directly addressed, yet. In addition, the paper materially contributes to the existing research regarding write-offs in particular and earnings management in general by introducing the real options approach to the analysis of accounting decisions.

The empirical studies that were conducted as a part of this dissertation, as well as a number of empirical studies conducted for US and Australian companies, reveal that write-offs are driven by earnings management as well as by asset impairment. However, these empirical studies barely analyze the circumstances under which one or the other

[17] See *Salewski*, *Siggelkow* and *Zülch* (2012), which is available at `http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2191499`.

influence prevails.[18] Hence, the aim of this paper is to analyze this issue in a very general setting and to motivate further research in this direction.

The model established in this paper introduces managerial discretion regarding the reporting of fixed asset write-offs without introducing information asymmetries. It is shown that in the chosen setting, in which discretion only arises when the asset is impaired and the discretion only enables the firm to delay the write-off, the payoff if the write-off is delayed can be interpreted as the payoff of a barrier option, or, more specifically, a down-and-in call. The firm decides to delay the write-off whenever the value of this barrier option exceeds the payoff it receives for transparent reporting (i.e. for immediately recognizing the write-off). The value of the barrier option increases in the benefits of transparent reporting as well as in the benefits of earnings management, and decreases in the costs of earnings management.

The findings of this paper present a rationale for the notion that in practice write-offs are often realized too late.[19] They indicate that if the benefits of earnings management are reduced and the costs of earnings management are increased, the probability that a firm delays write-offs can be materially decreased. In comparison, the payoff the firm receives for transparent reporting is less suitable to influence the use of earnings management in the write-off decision because it influences both the value of the barrier option and the payoff the firm receives if it does not delay the write-off.

This paper is currently under review for publication in the *European Accounting Review*. The co-authors of this paper are Alexander Lahmann and Henning Zülch. The input of the author of this present dissertation is in the provision of the theoretical background on IAS 36 and in cooperation in the development of the research question,

[18] *Minnick* (2011) showed that write-offs recognized by well-governed companies seem to reflect asset impairment, while those recognized by poorly governed companies reflect earnings management.
[19] See *Hoogervorst* (2012).

the derivation of the model and its implications, and the preparation of the draft manuscript.

1.3 Principal Research Contributions

This dissertation answers some of the most substantial questions concerning fixed asset write-offs according to IAS 36, which have remained unanswered – and in some cases even unasked – until now.

The empirical studies present much-needed insight into the mechanisms that drive fixed asset write-offs in Europe. Moreover, the study of the German setting shows that the enforcement mechanisms installed up to now do not suffice to completely prevent earnings management in the write-off decision. It is shown that different determinants drive the write-off decision and the write-off amount, and that the write-off amount in particular is materially driven by earnings management. Furthermore, it is found that there are different determinants depending on the institutional setting a company operates in, and that strong investor protection does not suffice to prevent earnings management. Overall, these findings show that neither the objective of the IFRS to provide useful information nor the goal to reach harmonization by the mandatory adoption of the IFRS in Europe have yet been reached.

The analytical paper on the derivation of an appropriate discount rate for the calculation of the value in use provides important understanding regarding the requirements of IAS 36 and their practicality. To date this discussion has been led from a finance perspective, but this article examines the accounting dimension and shows that a theoretically and practically suitable solution is still missing. This paper elucidates that further analytical discussion, and above all further guidance from the IASB is needed.

The analytical paper on the decision to apply earnings management introduces a new perspective to the accounting research in two ways. First, it explores the question regarding the situations in which earnings management is optimal, providing a marked contrast to previous work which simply questioned whether earnings management is generally applied. Second, the real options approach is established for the analysis of accounting decisions. This approach enables the analysis of various decisions in various settings, and is thus suitable for the analysis of a number of different accounting issues. The findings presented in this paper could ultimately help to find a mechanism that effectively prevents earnings management.

Overall, this dissertation has a material impact on the understanding of write-offs under IFRS. Especially considering the fact that prior research is scarce, this work discusses the most important questions regarding IAS 36. The nature of this standard as an intersection of accounting and finance is accounted for by introducing some finance techniques that bring further insights.

Furthermore, there are some practical implications related to the results of the studies contained in this dissertation. After all, (potential) shareholders should be aware of the fact that write-offs are used to manage earnings and which mechanisms drive the related decisions. Moreover, it should be regarded that comparison of the financial statements of companies domiciled in different countries should be undertaken cautiously, as comparability is not guaranteed. Similarly, enforcement institutions need to be aware that their present actions do not suffice to prevent earnings management. Contractors should be aware of the power they have in influencing a firm's tendency to manage earnings, as each contract that refers to accounting numbers without introducing costs of earnings management increases the probability that earnings are managed. Finally, the IASB should be aware of the remaining issues related to the implementation of IAS 36, especially regarding the calculation of the value in use on a pre-tax basis.

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2 Determinants of the Write-Off Decision under IFRS: Evidence from Germany

Chapter contents

Determinants of the Write-Off Decision under IFRS: Evidence from Germany*

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Abstract This study examines the factors that influence write-off decisions in German listed companies. Write-offs have been widely discussed, especially for the US-American market, and a relation to earnings management has been found in existing studies. German companies differentiate from the companies that have already been analyzed as they operate under different accounting standards (IFRS) and in a different institutional setting. Additionally managers are confronted with the task to derive the IFRS annual statements from the existing annual statements according to local GAAP which follow a differing objective. Based on a sample of 805 observations of German companies listed in the DAX, MDAX, TecDax and SDAX indices between 2004 and 2010, we analyze the impact of firm performance as well as reporting incentives on the write-off decision. We find that the write-off probability rises significantly with decreasing overall firm performance which is in line with the legal requirements. Additionally we find a strong relation of the write-off probability with unexpectedly high earnings, which is an indicator for income smoothing. Besides influencing the shareholders perception income smoothing can serve to minimize overall tax payments or to influence the banks risk assessment. In contrast with prior studies focusing on the US-American market, we found no evidence for other capital market motives like big bath accounting and management changes, neither could we confirm the hypothesis that earnings-based management compensation or leverage have a significant influence on the write-off decision. These results indicate that German managers aim to influence tax payments and potential lenders and not the perception of potential shareholders.

2.1 Introduction

According to IAS 36 *Impairment of Assets*, companies applying International Financial Reporting Standards (IFRS) are required to perform annual tests to detect the existence of indications that the value of long-lived assets covered by the scope of the standard may be impaired. If such an indication exists, the company is required to calculate the recoverable amount and compare it to the carrying amount of the asset under consideration. Although IAS 36 provides a detailed description of how to calculate the recoverable amount, the calculation entails large areas of discretion. As the recoverable amount is usually deduced from future expected cash flows, a situation arises in which information is distributed asymmetrically because management has more information than investors regarding future strategy and development, which gives rise to earnings management (*Schipper* (1989)). In our study we examine the factors that influence the write-off decision for German listed companies.

Earnings management concerning the recognition of write-offs has been discussed in several studies. However, the existing literature has been mainly focused on the US-American market (e.g. *Beatty* and *Weber* (2006); *Francis*, *Hanna* and *Vincent* (1996); *Riedl* (2004)). Little research has been conducted regarding the European IFRS setting, and to the best of our knowledge there does not exist a study on write-offs under IFRS in Germany. We concentrate on Germany for two reasons. First, Germany's publicly listed companies have been required to prepare their consolidated financial statements based on IFRS since 2005. Second, the institutional setting in Germany varies materially from that in the USA, which may give interesting insights for other countries with similar institutional settings.

The regulations concerning the impairment of assets vary between the US-GAAP and IFRS regimes, especially regarding the techniques used to decide whether an impairment loss is realized. ASC 360-10 *Impairment and Disposal of Long-Lived Assets* (formerly SFAS 144) requires a company to test the asset for recoverability as an initial step, by comparing the carrying amount with the sum of the estimated future undiscounted cash flows from further use of the asset. As a second step, the write-off amount is calculated as the difference between the carrying amount and the fair value of the asset. IAS 36 requires the company to compare the recoverable amount (the higher of value in use and fair value less costs to sell) with the carrying amount. If the carrying amount exceeds the recoverable amount the asset is impaired and is required to be written off by the difference between the two amounts. Thus, according to IFRS the write-off decision and the write-off amount are technically decided within the same step, while two steps are required according to US-GAAP. This may lead to differing factors influencing the write-off decision according to the two systems.

The USA can be classified as a common-law country with high shareholder protection, relatively low creditor protection, low ownership concentration and a developed equity market; therefore the regime is market-centered (*La Porta*, *Lopez-de-Silanes* and *Shleifer* (1998)). In contrast, Germany is a code-law country with low shareholder protection, high creditor protection, high ownership concentration and an underdeveloped equity market; therefore it is a bank-centered regime. *Leuz*, *Nanda* and *Wysocki* (2003) show that companies in countries with high investor protection, low ownership concentration and developed equity markets engage less in earnings management, suggesting different patterns of earnings management in the USA and Germany.

Additionally the German GAAP, which are still used to prepare individual financial statements, are materially influenced by stakeholder orientation. This stakeholder orientation results in prudence being the overriding principle, which means that losses have to be realized sooner rather than later, in contrast with gains which may only be realized when they occur. Furthermore, there exists a close link between tax accounting and local GAAP, motivating companies to manipulate their individual financial statements to minimize tax payments. Even though companies are required to reconcile their individual financial statements to IFRS for the preparation of consolidated financial statements, we assume that both the local GAAP and the IFRS accounts will ultimately be based on the same basic assumptions to avoid incongruity.

The results of our analysis show that the write-off decisions of German listed companies are materially influenced by firm performance. In contrast with different studies on the US-American market, we do not find big bath accounting to be significant, but we do find that the write-off decision is materially influenced by income smoothing. This finding is of interest to local as well as international regulatory and supervisory bodies, as well as to shareholders, lenders and financial analysts. IFRS are designed to provide useful information for (potential) shareholders of a company. All attempts at earnings management work against the fair presentation. Hence, to receive useful information, investors need to anticipate methods to manage earnings. As *Leuz*, *Nanda* and *Wysocki* (2003) show, earnings management decreases in enforcement. To reduce earnings management it is necessary to empower enforcement at specific points, which requires the government to be conscious of what methods of earnings management are used.

The remainder of this paper is organized as follows. In section 2.2 we give a brief overview of the existing literature and present the hypothesis development. In section 2.3 we describe our research design and the sample selection. Section 2.4 reports our results and sensitivity analysis. Our conclusions are presented in section 2.5.

2.2 Prior Research and Hypothesis Development

2.2.1 Prior Research

In this section we will give a short overview of the existing literature regarding the factors influencing the impairment of assets. We are aware that there has been an extensive amount of research conducted in this area, and therefore we will concentrate our literature review on the most influential studies which use similar regression models to ours.

Most of the existing literature examines the US-American market, but little research has been done which focuses on the write-off decision itself. *Minnick* (2011) examines the relation of the write-off decision with corporate governance. She finds a positive relation of percentage of outside directors, shareholder protection, pay-performance sensitivity, and CEO turnover with the write-off decision and a negative relation of board size and the write-off decision. By analyzing good and bad governed companies separately she finds that write-offs of good governed companies are related to economic factors while those of bad governed companies are opportunistic. Additionally she finds that good governed companies realize smaller impairment losses than bad governed companies do because the latter recognizes the loss only when it is so big that it cannot be ignored, anymore. *Loh* and *Tan* (2002) analyze macroeconomic and firm-specific factors that influence the write-off decision of companies in Singapore. They find that the unemployment rate, the GDP growth rate, the occupancy rate of properties and management changes are important determinants, whereas variables like the debt to asset ratio seem to be less significant. *Francis*, *Hanna* and *Vincent* (1996) analyze the causes of impairment losses of US-American companies before the adoption of SFAS 121 *Accounting for the Impairment of Long-Lived Assets and for Long-Lived Assets to be Disposed Of*, and find significant evidence for the influence of management changes and write-off history on the frequency and magnitude of write-offs. Interestingly the authors additionally find evidence against the income smoothing and big bath theory, since write-offs decrease in firm-years with unexpectedly high and unexpectedly poor performance.

Riedl (2004) compares the write-off characteristics of US-American companies before and after the adoption of SFAS 121. He finds that impairment losses were more closely related to management incentives and less closely related to economic effects after the change in accounting regulations. During the post-SFAS 121 period he shows that there is a significant correlation between management changes, as well as big bath accounting, and the magnitude of write-offs, but both factors were insignificant during the pre-SFAS 121 period. *Beatty* and *Weber* (2006) conduct a two-stage analysis estimating a joint probit and censored regression to analyze factors influencing the goodwill write-off decision and write-off magnitude in the SFAS 142 *Goodwill and Other Intangible Assets* adoption period. What makes these write-offs special is that in the transition period managers have to choose between a certain current write-off below the line and an uncertain future write-off included in income from continuing operations. Among other things the authors find that where net worth covenants exclude the effect of accounting changes, the frequency and magnitude of SFAS 142 write-offs rises for firms with a relatively high risk of future write-offs if a potential future above the line write-off will be highly capitalized, and if the bonus-based compensation plan explicitly excludes special items. Furthermore, the probability and magnitude of SFAS 142 write-offs decreases if the firm is traded on an exchange with explicit delisting requirements and in the tenure of the CEO, which the authors explain by the fact that a shorter CEO tenure increases the probability that the actual CEO did not make the original acquisition.

Cotter, *Stokes* and *Wyatt* (1998) investigate the determinants of the magnitude of impairment losses of Australian companies, focusing on management incentives. They find a significant relation between management changes and the magnitude of write-offs. They also find a relationship with the amount of cash reserves, which they interpret as the capacity to absorb impairment losses. Interestingly the authors do not find a significant impact on the magnitude of write-offs in respect of governance mechanisms such as the existence of an audit committee and auditing by the Big Six auditors.

AbuGhazaleh, *Al-Hares* and *Roberts* (2011) analyze the impact of earnings management on the goodwill write-off decision and its magnitude in the UK after the mandatory adoption of IFRS 3. The authors elaborate on the influence of corporate governance mechanisms in detail, and find that goodwill impairments are materially influenced by management incentives like management changes, big bath accounting and income smoothing. However, due to the strong relationship between goodwill impairments and good governance, they argue that managers use their discretion to convey private information rather than to manage earnings opportunistically. Finally, *Garrod*, *Kosi* and *Valentincic* (2008) analyze the write-off decision and its magnitude in small privately-held companies in Slovenia. They report that in the absence of agency problems and in an environment with high alignment between financial and tax reporting, companies tend to manage earnings using current asset write-offs, whereas fixed asset write-offs seem to be influenced mostly by regulatory factors.

Taken together, these studies suggest that there are strong incentives for large listed companies to use the write-off decision and its respective magnitude to manage earnings.

2.2.2 Development of Hypotheses

2.2.2.1 The Write-Off Decision

According to IAS 36, a company is required to assess whether there is an indication that the asset under consideration may be impaired at the end of each reporting period. In making this assessment, as a minimum the company is required to consider internal and external factors described in IAS 36.12 as follows:

- a significant decline in the asset's market value
- significant changes in technological, market, economic or legal environment
- increased market interest rates or other market rates of return on investment
- carrying amount of total net assets exceeds market capitalization
- obsolescence or physical damage of an asset
- significant changes in the extent to which an asset is used
- economic performance of the asset is worse than expected

If there is an indication that the asset may be impaired, the recoverable amount of the asset must be calculated and compared to the carrying amount. A positive difference between carrying amount and recoverable amount must be written off. The recoverable amount is defined as the higher of value in use and fair value less costs to sell, where the value in use is the present value of future cash flows from further use of the asset and its final disposal. Ideally, the fair value less costs to sell shall be derived from a binding sale agreement. If a sale agreement does not exist it is to be derived from an active market or, failing that, from the best information available to reflect the amount that an entity could obtain, at the end of the reporting period, from the disposal of the asset in an arm's length transaction between knowledgeable willing parties, after deducting the cost of disposal. As a binding sale agreement will rarely be available and for most assets an active market does not exist, the fair value less costs to sell is typically calculated as the present value of future cash flows that a market participant could gain with the asset. In contrast to the calculation of the value in use, firm-specific factors like synergies may not be included.

The assessment of whether an indication exists that the asset may be impaired, as well as the calculation of the recoverable amount, requires insider knowledge with respect to the status, usage and profitability of the asset under consideration, giving the management room for individual judgment. According to *Healy* and *Wahlen* (1999), "earnings management occurs when managers use judgment in financial reporting and in structuring transactions to alter financial reports to either mislead some stakeholders about the underlying economic performance of the company or to influence contractual outcomes that depend on accounting numbers". The occurrence of earnings management thus depends on the existence of certain reporting incentives that motivate the management to manipulate earnings. We assume that the write-off decision is affected by both a decrease in the recoverable amount of the asset under the carrying amount, which we will call impairment, as well as reporting incentives.

2.2.2.2 Impairment

IAS 36 requires an impairment write-off to be made whenever an asset's recoverable amount falls below the asset's carrying amount. The calculation of the recoverable amount is only required if there is an indication that the asset may be impaired. Following *Cotter*, *Stokes* and *Wyatt* (1998), we argue that if there is an indication that the asset may be impaired and the carrying amount exceeds the recoverable amount, the management has an incentive to write off for at least two reasons: legal liability to recognize the impairment loss, and the comparative advantage of providing information about their firm's expected future cash flows. *La Porta*, *Lopez-de-Silanes* and *Shleifer* (1998) classify Germany as a country with relatively high enforcement, and therefore non-compliance with the accounting standards is relatively risky. The identification of companies that have assets which are impaired is based on the assumption that impairment is associated with poor firm performance. Hence we suggest our first hypothesis:

H1: The write-off probability is higher for companies with worse performance.

We include three proxies for firm performance in our analysis, the choice of which is in part influenced by the specification of IAS 36. The first proxy is income before write-offs. IAS 36.14 (b) states that operating profits which are worse than expected are an indicator that the asset might be impaired. Thus we expect a negative correlation between the write-off probability and income before write-offs. As the calculation of the recoverable amount is mostly based on expected future cash flows, our second proxy for firm performance is the operating cash flow of the company. IAS 36.14 (b) also states that net cash flows that are worse than expected indicate that the asset might be impaired. Therefore we expect a negative correlation between the write-off probability and the operating cash flow. The necessity to write off follows from the relation of market value to carrying amount. Thus our third proxy for firm performance is the market to book ratio. IAS 36.12 (d) identifies a market to book ratio below one as an indicator that the asset under consideration is impaired. As with earnings before write-offs and the operating cash flow, we expect a negative correlation between the market to book ratio and the write-off probability.

2.2.2.3 Reporting Incentives

Following *Healy* and *Wahlen* (1999), we divide reporting incentives into two broad groups: capital market motivations and contracting motivations. We do not explicitly analyze regulatory requirements since we do not partition our sample by industries. We incorporate overall regulations in our analysis through control variables such as firm size.

Capital Market Motivations The perception of the company by stock market participants is probably one of the most important targets for management, since actual and potential shareholders control the share price. Therefore, positively influencing their perception is probably one of management's main incentives. One way to achieve this goal might be to manage current year's earnings performance. Following the extensive income smoothing literature, we assume that good earnings performance is related to a high write-off probability. The idea behind this is that the management tries to meet the shareholders' expectations. According to *Moses* (1987), we can define income smoothing as an "effort to reduce fluctuations in reported earnings", meaning that the management uses the write-off decision as a "smoothing device" to reduce the divergence of reported earnings from the expected number. The notion of income smoothing is based on the assumption that shareholders perceive actual earnings as a signal for future earnings, and that smoothed earnings allow for more precise forecasts, which the capital market rewards with higher share prices. In support of this assumption, *Kasznik* and *McNichols* (1999) report that even though financial analysts do not adjust their forecasts for companies that consecutively meet their expectations, the market grants a market premium.

In the German setting there are two further arguments for income smoothing. Regarding the individual annual statements, high tax-book conformity exists. According to *Graham* and *Smith* (1999), high tax-book conformity is an incentive to smooth earnings because it reduces overall tax expenses under a progressive tax rate. Since we assume that not all earnings management will be undone in the reconciliation process, the income smoothing in individual annual statements will impact the consolidated financial statements according to IFRS. The second argument is that debt financing is relatively important in Germany because the equity market is underdeveloped. According to *Trueman* and *Titman* (1988), material debt financing is an incentive to smooth earnings because if the lender observes a low volatility in the company's earnings the assessment of the probability of bankruptcy is lowered, which in turn results in decreased borrowing costs.

Some empirical studies (e.g. *Francis*, *Hanna* and *Vincent* (1996)) find significant evidence for the existence of income smoothing in the write-off decision, but other studies find that there is no such relationship (e.g. *Riedl* (2004)). We assume that managers apply income smoothing, meaning that impairment losses will be recognized in years with unexpectedly high income before impairment losses:

H2: Companies with unexpectedly high earnings before impairment losses have a higher write-off probability.

Closely related to the assumption of income smoothing is that of big bath accounting. Big bath accounting means that the management accumulates problems until it finally recognizes a huge impairment loss in a year in which the company has realized an unexpectedly low income anyway. Following this approach offers several advantages (see *Strong* and *Meyer* (1987)). First, the management in this way establishes a safety cushion for subsequent years in which it will be easier to meet the shareholders' expectations. Second, it is argued that recognizing a large one-time loss signals that past problems have been solved. The third advantage is a merely arithmetic: lowering earnings in the current year ensures high earnings growth for the future. Another more psychological argument on which the big bath technique may be based is that if the situation is already bad, making it a little worse will in most cases do no harm, either to management reputation or to earnings expectations (see *Walsh*, *Craig* and *Clarke* (1991)). Thus we assume that managers apply big bath accounting, meaning that impairment losses will be realized in years with unexpectedly low income before impairment losses:

H3: Companies with unexpectedly low earnings before impairment losses have a higher write-off probability.

While H2 and H3 seem to be contradictory at first sight, *Kirschenheiter* and *Melumad* (2002) prove that if the reporting environment permits discretion, the optimal strategy of management is to smooth income if good news occurs and use big bath accounting if bad news occurs.

Another incentive that influences the write-off decision is a change in management. There are different reasons for incoming managers to recognize write-offs in their first year (see *Wells* (2002)). One of these is that they are not held responsible for past performance, and thus they may explicitly attribute the impairment losses to the preceding management. This is often referred to as "cleaning the decks", illustrating the fact that new managers tend to realize impairment losses that have been delayed in prior years. In this way it is possible to anticipate future losses without any loss of reputation, resulting in increasing earnings in subsequent years. The result of high write-offs in the first year is that income in future years is relieved of these expenses, so that an improving earnings trend can be reported from the first year of tenure onwards. In support of this theory, *Moore* (1973) finds that companies with recent management changes show a significantly greater proportion of income-reducing discretionary accounting decisions. A number of studies report the same result for the relationship between management changes and write-offs (e.g. *Beatty* and *Weber* (2006); *Francis*, *Hanna* and *Vincent* (1996); *Riedl* (2004)), whereas others find no significant relationship (e.g. *Cotter*, *Stokes* and *Wyatt* (1998)).

H4: Firm-years in which a management change has occurred have a higher write-off probability.

Contrating Motivations There are different kinds of contracts that rely on accounting data. Two kinds that are frequently used are credit agreements and management compensation contracts, where credit agreements are usually tied to leverage and management compensation contracts often refer to earnings. The leverage of the company under consideration may influence credit agreements in two ways. First, the level of borrowing costs is based on the assessment of financial risk for which leverage is an important determinant, meaning that higher leverage can result in higher borrowing costs. Second, most credit agreements contain strict regulations concerning leverage, called debt covenants. The breach of a given covenant can lead to an immediate repayment claim from the creditor, which would result in extensive liquidity problems for most companies. Following the results of *Duke* and *Hunt* (1990), leverage can be used as a proxy for the closeness to debt covenant restrictions. *Sweeney* (1994) also provides evidence in support of the hypothesis that managers of firms approaching technical default respond with income-increasing accounting changes. Regarding the write-off decision, this means that the write-off probability decreases, delivering our fifth hypothesis:

H5: Companies with higher leverage have a lower write-off probability.

Management compensation is commonly divided into a fixed and a variable part, where the latter has a short-term and a long-term component. The short-term component is usually based on a measure of the company's success, whereas the long-term component contains a stock-option plan. If impairment losses influence the figure standing for success (e.g. EBIT, profit) we assume that the management has an incentive to delay write-offs to later years in order to increase the current period's income (see *Watts* and *Zimmerman* (1978)). Similarly, *Beatty* and *Weber* (2006) find that bonus plans that do not explicitly exclude impairment losses reduce the write-off probability. Therefore, our sixth hypothesis is as follows:

H6: Companies which grant managers earnings-based bonuses that are affected by impairment losses have a lower write-off probability.

2.3 Research Design

2.3.1 Sample Selection

Our full sample is comprised of all the non-financial German companies that were listed in the German DAX, MDAX, TecDax and SDAX indices between 2004 and 2010, with a complete IFRS dataset available in the Worldscope database. To be able to calculate variables that refer to previous year data, such as expected earnings, we had to exclude the first observation, and the first observation after a gap, for all companies. Our full sample contains 165 firms, providing 805 firm-years. To test for the influence of management changes and earnings-based bonus payments we hand-collected information on these two variables as described below for all companies that were listed in HDAX (a combination of DAX, MDAX and TecDax) between 2004 and 2010. Therefore we excluded from the sample all companies that were not listed in HDAX during the period under consideration, and additionally had to exclude a further 170 and 182 observations for the management change sample and the earnings-based bonus sample respectively due to a lack of information. Table A.1 describes the process of sample selection for all three samples.

(Table A.1 About Here)

2.3.2 Model and Variable Measurement

Since the decision to write off is a dichotomous variable, we used a probit regression to examine the influence of the impairment and reporting incentives described above on the write-off decision. We include multiple firm-years of the companies examined in our analysis, and thus apply a panel research design. To implement our analysis we use the following random effects probit regression:

$$\begin{aligned}\Pr(WO_{it}=1) = {} & \beta_0 + \beta_1\mathrm{INCOME}_{it} + \beta_2\mathrm{OCF}_{it} + \beta_3\mathrm{MTB}_{it}\\ & + \beta_4\mathrm{BIGBATH}_{it} + \beta_5\mathrm{INCSMOOTH}_{it} + \beta_6\mathrm{DTA}_{it}\\ & + \beta_7\mathrm{FIRMSIZE}_{it} + \beta_8\mathrm{BIG4}_{it} + \beta_9\mathrm{LISTING}_{it}\\ & + \beta_{10-15}\mathrm{YEAR}_t + \epsilon_{it}.\end{aligned} \tag{2.3.1}$$

To test the influence of management changes we run the following probit regression on our management change sample:

$$\begin{aligned}\Pr(WO_{it}=1) = {} & \beta_0 + \beta_1\mathrm{INCOME}_{it} + \beta_2\mathrm{OCF}_{it} + \beta_3\mathrm{MTB}_{it}\\ & + \beta_4\mathrm{BIGBATH}_{it} + \beta_5\mathrm{INCSMOOTH}_{it}\\ & + \beta_6\mathrm{DTA}_{it} + \beta_7\mathrm{MC}_{it}\\ & + \beta_8\mathrm{FIRMSIZE}_{it} + \beta_9\mathrm{BIG4}_{it} + \beta_{10}\mathrm{LISTING}_{it}\\ & + \beta_{11-16}\mathrm{YEAR}_t + \epsilon_{it}.\end{aligned} \tag{2.3.2}$$

Similarly, to analyze the influence of earnings-based bonus payments we run the following probit regression on our earnings-based bonus sample:

$$
\begin{aligned}
\Pr(\mathrm{WO}_{it}=1) = {} & \beta_0 + \beta_1 \mathrm{INCOME}_{it} + \beta_2 \mathrm{OCF}_{it} + \beta_3 \mathrm{MTB}_{it} \\
& + \beta_4 \mathrm{BIGBATH}_{it} + \beta_5 \mathrm{INCSMOOTH}_{it} \\
& + \beta_6 \mathrm{DTA}_{it} + \beta_7 \mathrm{EBB}_{it} \\
& + \beta_8 \mathrm{FIRMSIZE}_{it} + \beta_9 \mathrm{BIG4}_{it} + \beta_{10} \mathrm{LISTING}_{it} \\
& + \beta_{11-16} \mathrm{YEAR}_t + \epsilon_{it}.
\end{aligned} \tag{2.3.3}
$$

The endogenous variable WO_{it} is a dichotomous variable that takes the value 1 if company i recognizes a write-off in t, and takes the value 0 otherwise. We calculate total write-offs as the sum of write-offs on goodwill, other intangibles and property, plant and equipment. In contrast to *Garrod*, *Kosi* and *Valentincic* (2008), current asset write-offs are not included in the analysis as they are excluded from the scope of IAS 36. Hence, the dichotomous variable WO_{it} is equal to 1 whenever total write-offs exceed 0. We decided to represent the independent non-indicator variables as ratios rather than as levels to control for scale. Thus INCOME_{it} represents the net income of company i in t corrected for any write-offs divided by total assets of company i in $t-1$. OCF_{it} is company i's operating cash flow in t divided by total assets of company i in $t-1$. MTB_{it} represents company i's market to book ratio in t. Similar to *Francis*, *Hanna* and *Vincent* (1996), to proxy for income smoothing and big bath accounting we first calculate an earnings management indicator EMI_{it}, which is the difference of company i's net income in t corrected for taxes and write-offs and company i's earnings before taxes in $t-1$ divided by company i's total assets in $t-1$. The definition of the earnings management indicator is based on the choice of a random walk model for the development of earnings before taxes predicting actual earnings being equal to last year's earnings (see *Moses* (1987)). If the earnings before taxes and write-offs in t are unexpectedly high the earnings management indicator takes a positive value; if they are unexpectedly low it is negative. INCSMOOTH_{it} proxies for income smoothing of company i in t. It takes the value of the earnings management indicator EMI_{it} if this exceeds 0, and is 0 otherwise. We do not proxy for income smoothing using a dichotomous variable because if the management tries to smooth earnings the necessity to write off rises with the degree to which actual and expected earnings deviate. Similarly, BIGBATH_{it} proxies for big bath accounting of company i in t and equals the earnings management indicator EMI_{it} if this falls below 0, and is 0 otherwise. As the choice of the ratio used to proxy for leverage does not play an important role (see *Duke* and *Hunt* (1990)) we use DTA_{it}, which represents the ratio of total debt of company i in t divided by total assets of company i in t.

The variables MC_{it} and EBB_{it} were hand-collected. *Healy* (1985) argues that compensation plans will generally contain upper and lower bounds, and proves that management has an incentive to choose income-increasing accruals (i.e. no write-off) only if neither the lower nor the upper bound defined in the bonus plan is binding. If one of these bounds is binding the management has an incentive to choose income-decreasing accruals (i.e. to write off) in order to maximize their future payments. We collected the information on compensation plans from annual reports. Due to a lack of information on bounds or exact measurement for the earnings-based compensation, we decided to proxy for earnings-based bonus payments using the dichotomous variable EBB_{it}, which equals 1 if the management receives earnings-based bonus payments that are affected by impairment losses, and is 0 otherwise. We exclude those firm-years for which we only found general statements in the annual reports. The information on management changes was collected from the homepage of the DGAP *Deutsche Gesellschaft für Ad-hoc-Publizität mbH*, which is a portal that companies can use to fulfill the duty to publish ad hoc disclosures. MC_{it} is a dichotomous variable that equals 1 if changes in the management board of company i occurred in t, and is 0 otherwise. Companies that do not use the services of DGAP were excluded from the sample.

In addition to the variables measuring the hypothesized effects, we included some control variables measuring other factors that could influence the tendency to write off. Following the existing literature, we include measures for company-size, the size of the auditor and listing on foreign stock exchanges. FIRMSIZE_{it} is the natural logarithm of the total assets of company i in t. BIG4_{it} is a dichotomous variable equal to 1 if company i was audited by a Big 4 Four audit company in t and 0 otherwise. Finally, LISTING_{it} is an indicator variable equal to 1 if company i was listed on a foreign stock exchange in t and 0 otherwise. YEAR_t are dummy variables for the observation year, which we included to control for macroeconomic effects.

2.4 Results

2.4.1 Descriptives and Correlation Analysis

Table A.2 provides descriptive statistics for our sample firms.

(Table A.2 About Here)

We find that an impairment loss was realized in about 60% of our sample firms-years. Average income before write-offs amounts to 4% of lagged total assets, and average operating cash flow is about 9% of lagged total assets. The mean market to book ratio amounts to 2.56. We further find that the average leverage amounts to 20.82%. In about 83% of our earnings-based bonus payments sample-firm-years managers received earnings-based bonus payments that were affected by write-offs. In about 26% of the management change sample-firm-years a management change had occurred.

Table A.3 partitions the observations according to those firm-years in which an impairment loss was recognized and those in which there was no impairment loss.

(Table A.3 About Here)

Regarding the impairment variables, we find the net income before write-offs to be significantly higher for non-write-off firm-years than for write-off firm-years; this is consistent with prior research. Interestingly we do not find significant differences in mean values between the two groups in respect of operating cash flow and market to book ratio, indicating that managers base their write-off decision on earnings measures rather than on cash flow measures. Regarding the reporting incentives, we find significant differences in the means of leverage, management change and earnings-based bonus payments. Contrary to our expectations the mean leverage is higher for write-off firm-years than for non write-off firm-years which argues against Hypothesis 5 that the managers of companies with high leverage will try to delay impairments. Instead, it supports the impairment hypothesis that companies in a worse financial situation, i.e. which are higher leveraged, will have a higher write-off probability. As expected, the mean management change indicator is significantly higher for write-off firm-years indicating that incoming managers tend to realize impairment losses either to clean the decks or to anticipate future losses, or both. Consistent with our expectations, the mean earnings-based bonus payment indicator is significantly lower for write-off firm-years, suggesting that managers who receive compensations that do not exclude write-off effects write off less frequently than managers whose compensation is not affected by write-offs. We do not find significant differences in terms of our big bath proxy or our income smooth proxy. Additionally, we find that write-off firm-years are associated with significantly higher company size, higher frequency of auditing by a Big Four audit company, and listing on a foreign exchange.

Table A.4 reports the pair wise Pearson and Spearman correlation coefficients for all variables analyzed. The correlations are relatively low, showing that our results are not influenced by multicolliniarity.

(Table A.4 About Here)

2.4.2 Regression Results

2.4.2.1 Impairment Variables

Table A.5 presents the results from our three probit regressions.

(Table A.5 About Here)

Regarding the impairment variables, we find net income before write-offs to be significant at the 1% level for all three models. The sign is negative as predicted, indicating that lower income is associated with higher write-off probability. This confirms Hypothesis 1 that the write-off probability rises with decreasing firm performance. Operating cash flow is insignificant for all three models. This result shows that contrary to what the standard-setter requires, the impairment decision does not seem to be based on the expected cash flows but on the accruals-based measure of income before write-offs. Alternatively, this insignificance could result from using the overall operating cash flow as proxy for the free cash flow generated by the assets tested for impairment.

Contrary to our expectations the market to book ratio has a positive sign for all three models, indicating that the write-off probability increases with increasing market to book ratio. However, this result is significant at the 10% level for model 1 and model 3 only, and completely insignificant in model 2, including the management change indicator. Thus it is not very robust. The positive sign could indicate that the market to book ratio cannot be interpreted as an indicator for the market value of the asset being higher than its book value, resulting in no necessity to write-off, but instead it should be interpreted as a measure for growth options. *Cotter*, *Stokes* and *Wyatt* (1998) argue that a high market to book ratio results from high growth options, and that companies with high growth options are riskier and thus more susceptible to impairments.

2.4.2.2 Reporting Incentives

Regarding the reporting incentives, we find a significant positive influence of income smoothing at the 1% level for models 1 and 3 and at the 5% level for model 2, while big bath and leverage are insignificant for all three models. Thus, our findings support Hypothesis 2 while we have to reject Hypotheses 3 and 5. Analyzing the US-American market, *Riedl* (2004) found the opposite results, with a significant negative influence of unexpectedly low earnings being a sign of big bath accounting, a significant negative influence of leverage supporting his debt-covenant hypothesis and no significant influence of income smoothing.

The insignificance of big bath in this study could result from the German setting. As stated earlier, German companies' individual financial statements are driven by prudence and creditor protection as well as the attempt to minimize tax payments. These factors result in a tendency to recognize expenses sooner rather than later and in good years rather than in bad. Due to credibility considerations the early realization of losses in the individual and tax statements also results in an early realization of losses in the consolidated financial statements according to IFRS. The insignificance of leverage could result from the assumption that leverage can be used to proxy for the closeness to debt covenants. Additionally German companies historically rely heavily on debt, and a high leverage in most cases leads to the banks being more attentive to possible earnings-increasing procedures, thereby reducing the room for earnings management. Regarding the management change variable in model 2, we could not find a significant influence, indicating that German managers do not tend to realize impairment losses in their first year. The insignificance could also result from the fact that we considered all changes in the management board to be of interest and did not differentiate between different positions or situations. The earnings-based bonus payment indicator in model 3 is just below the 10% level of significance (i.e. 11.4%). This insignificance could result from the fact that we did not account for caps and floors of the compensation plans due to a lack of information.

2.4.2.3 Control Variables

We find a significant positive relationship between the impairment probability and the company size in all three models. Auditing by a Big Four audit company has a significant influence in model 2 at the 5% level, but is insignificant in models 1 and 3. The indicator for listing on a foreign stock exchange is only marginally significant in model 1 and insignificant in models 2 and 3. Untabulated year-dummies have positive signs (except for 2007 which is negative), but all are insignificant except for 2006 in model 1. As the financial crises had not begun in 2006 but GDP was rising significantly instead, the significant positive influence could result either from income smoothing or from a learning effect after mandatory IFRS-adoption in 2005. In model 2, 2006 is also insignificant and 2007 becomes positive, while 2008 and 2009 are negative. In model 3, all year dummies are positive. The year 2006 is significant at the 1% level, and 2008 becomes significant at the 10% level. This could be interpreted as the influence of the financial crises, but it is a weak result due to a lack of robustness.

2.4.3 Sensitivity

To validate our findings, we conducted a series of sensitivity analyses. Results are presented in table A.6.

(Table A.6 About Here)

We replaced net income before write-offs with the return on assets, operating cash flow with sales and the market to book ratio with the change in market to book ratio compared with the preceding year. Additionally we estimated our model using a panel logit regression. Finally, we excluded all observations from 2005, because 2005 was the year of mandatory IFRS adoption. Net income (or return on assets), the income smooth variable and company size remained significant at the 1% level through all variations. The operating cash flow becomes marginally significant with a positive sign if we include market to book ratio change instead of market to book ratio, but it remains insignificant in all other model specifications. A positive influence of operating cash flow on the write-off probability implies that the operating cash flow does not proxy for impairment but for the capacity to absorb impairment losses, as *Cotter*, *Stokes* and *Wyatt* (1998) argue. The significance of market to book ratio fluctuates from 4.4% to 16% between the different variations, always with a positive sign. Market to book ratio change is insignificant. Big bath and leverage remain insignificant through all model variations as well as auditing by a Big Four audit company. The indicator variable for the listing on a foreign stock exchange falls just below the 10% significance level if we include the return on assets instead of the income before write-offs. Overall we find that the write-off decision is materially influenced by income before write-offs, income smoothing and the firm size, and that this main result is not altered by different model variations.

2.5 Conclusions

This study investigates the factors that influence write-off decisions in German companies applying IFRS. We find that the write-off probability materially increases in situations of decreasing net income before write-offs, and in a context of increasing firm size. Furthermore, the write-off decision is materially influenced by income smoothing. Overall our findings support the hypothesis that earnings management behavior in Germany materially deviates from that in Anglo-American countries like the USA. The write-off decision is materially influenced by income smoothing, while other reporting incentives do not have a significant impact. In contrast to prior studies – most of which analyze the US-American market – we could find no evidence for big bath accounting, and neither were there relationships between impairments and earnings-based bonus payments, management changes or leverage.

Our study contributes to the existing literature in several ways. First, only a minimal amount of research has been conducted regarding the write-off decision under IFRS, with the existing research mainly focusing on the US-American market. As there are material differences between US-GAAP and IFRS, especially regarding the write-off decision, our study gives insights into the importance of earnings management in the application of IAS 36. Second, we analyze the write-off behavior in a different institutional setting. Germany is a bank-centered code-law country with low shareholder protection, high creditor protection, high ownership concentration and an underdeveloped equity market. Therefore the incentives for earnings management are likely to be very different for German firms than for US-American firms since the USA is a market-centered common-law country with high shareholder protection, relatively low creditor protection, low ownership concentration and a developed equity market.

Our results are of interest to German regulatory and supervisory bodies as they prove that German companies apply significant discretion in their write-off decisions, which could possibly be decreased by focusing enforcement on this special issue. Additionally our findings should be of interest to all shareholders and lenders, as well as financial analysts, in interpreting financial reports according to IFRS. Further, the results are of interest to the IASB as we provide evidence that the regulation gives room for earnings management and its use in Germany.

However, our study is subject to some limitations. First, our definition of the management change variable is based on the assumption that all changes in the management board matter. A further analysis of changes in different positions on the management board could provide further insight into the influence of management changes. Second, the definition of the earnings-based compensation variable does not include the fact that most compensation plans have caps and floors. If this information was available and included in a similar study, additional insight could be gained regarding the impact of management compensation. Finally, because we only analyzed German publicly listed companies, we could not analyze the effect of different institutional settings. Therefore we cannot definitely identify what leads German companies to apply income smoothing extensively – whether it results from being bank-centered, from tax-book conformity, or from other factors. Hence, in future research it could be interesting to analyze the write-off decision under IFRS in a set of European companies.

Appendix A

Table A.1: Sample selection

	Full sample		Management change sample		Earnings-based bonus payments sample	
	companies[b]	Firm-years	companies[b]	Firm-years	companies[b]	firm-years
Companies listed in DAX, MDAX, TecDax or SDAX between 2004 and 2010	229	1603	229	1603	229	1603
Financial companies	(35)	(245)	(35)	(245)	(35)	(245)
Not German	(17)	(119)	(17)	(119)	(17)	(119)
No complete dataset		(166)		(166)		(166)
No IFRS		(88)		(88)		(88)
First firm-years[a]		(180)		(180)		(180)
Non-HDAX company			(47)	(223)	(47)	(223)
No sufficient data on management changes				(170)		
No sufficient data on earnings-based bonus payments						(182)
Final sample of firm-years	165	805	85	412	98	400

[a] For the calculation of ratios that revert to previous year data the first observation of each company and the first observation after a gap in the data had to be excluded.

[b] The number of companies excluded from the sample is given for financial, foreign and non-HDAX companies only, as the other criteria usually change from year to year and thus do not result in the exclusion of a whole company on a stand-alone basis. However, the combination of different exclusion criteria might well result in the complete exclusion of a company. Therefore, the final sample of firms cannot be calculated from the numbers given above because the sample reduced due to companies that were eliminated cumulatively because of an incomplete dataset, no IFRS, the first reporting periods and a lack of sufficient data on management changes/earnings-based bonus payments.

Table A.2: Descriptive statistics

	Mean	Standard Deviation	Min	25%-Quantile	Median	75%-Quantile	Max	N
WO_{it}	0.60	0.49	0.00	0.00	1.00	1.00	1.00	805
$INCOME_{it}$	0.04	0.14	-0.88	0.01	0.04	0.09	1.28	805
OCF_{it}	0.09	0.11	-0.59	0.05	0.08	0.13	0.54	805
MTB_{it}	2.56	2.48	-1.84	1.28	1.93	2.92	28.57	805
$BIGBATH_{it}$	-0.03	0.07	-0.79	-0.02	0.00	0.00	0.00	805
$INCSMOOTH_{it}$	0.05	0.12	0.00	0.00	0.01	0.05	1.58	805
DTA_{it}	20.82	16.50	0.00	6.74	18.74	31.69	98.02	805
MC_{it}	0.26	0.44	0.00	0.00	0.00	1.00	1.00	412
EBB_{it}	0.83	0.38	0.00	1.00	1.00	1.00	1.00	400
$FIRMSIZE_{it}$	14.10	1.89	9.45	12.77	13.86	15.05	19.38	805
$BIG4_{it}$	0.83	0.37	0.00	1.00	1.00	1.00	1.00	805
$LISTING_{it}$	0.10	0.30	0.00	0.00	0.00	0.00	1.00	805

Table A.2 provides descriptive statistics for the sample observations.

Variable definitions:

WO_{it}	an indicator variable equal to 1 if company i recognized a write-off in t and 0 otherwise
$INCOME_{it}$	net income of company i in t corrected for impairment losses recognized by company i in t divided by total assets of company i in $t-1$ of company i in t
OCF_{it}	the operating cash flow from company i in t divided by total assets of company i in $t-1$
MTB_{it}	the market to book ratio of company i in t
$BIGBATH_{it}$	proxy for unexpectedly low earnings equal to EMI if EMI <0 and 0 otherwise
$INCSMOOTH_{it}$	proxy for unexpectedly high earnings equal to EMI if EMI >0 and 0 otherwise
DTA_{it}	the total debt of company i in t divided by total assets of company i in t
MC_{it}	an indicator variable equal to 1 if a management change occurred at company i in t and 0 otherwise
EBB_{it}	an indicator variable equal to 1 if company i's management received earnings-based bonus payments in t and 0 otherwise
$FIRMSIZE_{it}$	the natural logarithm of the total assets of company i in t
$BIG4_{it}$	an indicator variable equal to 1 if company i was audited by a Big Four audit company (PricewaterhouseCoopers, KPMG, Ernst & Young, Deloitte) in t and 0 otherwise
$LISTING_{it}$	an indicator variable equal to 1 if company i was listed on a foreign stock exchange in t and 0 otherwise

Table A.3: Descriptive statistics separated by write-off and non-write-off firm-years

	Non-write-off firm-years (N=319)			Write-off firm-years (N=486)		
	Mean (p-value)	Median	Standard Deviation	Mean (p-value)	Median	Standard Deviation
INCOME_{it}	0.07 (0.000)	0.06	0.14	0.02	0.03	0.14
OCF_{it}	0.10 (0.144)	0.09	0.13	0.08	0.08	0.09
MTB_{it}	2.69 (0.217)	1.98	2.22	2.47	1.88	2.63
BIGBATH_{it}	-0.02 (0.719)	0.00	0.08	-0.03	0.00	0.07
INCSMOOTH_{it}	0.05 (0.370)	0.01	0.14	0.05	0.01	0.10
DTA_{it}	16.38 (0.000)	13.69	14.74	23.74	21.88	16.95
MC_{it}	0.19 (0.031)	0.00	0.39	0.29	0.00	0.45
EBB_{it}	0.90 (0.012)	1.00	0.31	0.80	1.00	0.40
FIRMSIZE_{it}	13.18 (0.000)	13.04	1.46	14.70	14.45	1.91
BIG4_{it}	0.75 (0.000)	1.00	0.43	0.88	1.00	0.32
LISTING_{it}	0.05 (0.000)	0.00	0.22	0.14	0.00	0.35

Table A.3 shows the descriptive statistics differentiated by write-off and non-write-off firm-years. Significance levels of differences in means are reported in parentheses.

Table A.4: Correlation analysis

	WO_{it}	$INCOME_{it}$	OCF_{it}	MTB_{it}	$BIGBATH_{it}$	$INCSMOOTH_{it}$	DTA_{it}	MC_{it}	EBB_{it}	$FIRMSIZE_{it}$	$BIG4_{it}$	$LISTING_{it}$
WO_{it}	1.000	-0.229	-0.062	-0.065	-0.049	-0.062	0.223	0.107	-0.126	0.418	0.177	0.141
		(0.000)	(0.079)	(0.064)	(0.165)	(0.079)	(0.000)	(0.031)	(0.012)	(0.000)	(0.000)	(0.000)
$INCOME_{it}$	-0.193	1.000	0.492	0.450	0.415	0.404	-0.344	-0.137	0.085	-0.105	-0.029	-0.036
	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)	(0.091)	(0.003)	(0.415)	(0.307)
OCF_{it}	-0.052	0.417	1.000	0.387	0.189	0.175	-0.190	-0.093	0.000	-0.048	0.008	0.026
	(0.144)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.060)	(0.994)	(0.174)	(0.824)	(0.463)
MTB_{it}	-0.044	0.295	0.301	1.000	0.271	0.294	-0.200	-0.039	0.049	-0.114	-0.019	-0.057
	(0.217)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.433)	(0.326)	(0.001)	(0.586)	(0.108)
$BIGBATH_{it}$	-0.013	0.371	0.178	-0.004	1.000	0.709	-0.075	-0.071	-0.001	0.030	0.030	-0.018
	(0.719)	(0.000)	(0.000)	(0.900)		(0.000)	(0.033)	(0.151)	(0.982)	(0.392)	(0.393)	(0.605)
$INCSMOOTH_{it}$	-0.032	0.407	0.030	0.173	0.151	1.000	-0.197	-0.027	-0.041	-0.188	-0.008	-0.067
	(0.370)	(0.000)	(0.399)	(0.000)	(0.000)		(0.000)	(0.588)	(0.415)	(0.000)	(0.829)	(0.058)
DTA_{it}	0.218	-0.318	-0.146	-0.089	-0.033	-0.110	1.000	0.081	-0.098	0.344	-0.043	0.105
	(0.000)	(0.000)	(0.000)	(0.012)	(0.351)	(0.002)		(0.102)	(0.051)	(0.000)	(0.221)	(0.003)
MC_{it}	0.107	-0.078	-0.090	0.071	0.011	-0.030	0.103	1.000	-0.094	-0.033	-0.030	0.038
	(0.031)	(0.113)	(0.069)	(0.153)	(0.823)	(0.541)	(0.036)		(0.117)	(0.499)	(0.541)	(0.448)
EBB_{it}	-0.126	0.090	-0.009	0.042	-0.040	0.003	-0.089	-0.094	1.000	0.005	-0.145	0.074
	(0.012)	(0.073)	(0.856)	(0.403)	(0.428)	(0.952)	(0.074)	(0.117)		(0.927)	(0.004)	(0.143)
$FIRMSIZE_{it}$	0.394	0.022	-0.011	-0.148	0.108	-0.159	0.263	-0.008	0.026	1.000	0.290	0.404
	(0.000)	(0.536)	(0.764)	(0.000)	(0.002)	(0.000)	(0.000)	(0.879)	(0.609)		(0.000)	(0.000)
$BIG4_{it}$	0.177	-0.004	0.057	0.011	0.027	-0.031	-0.089	-0.030	-0.145	0.280	1.000	0.153
	(0.000)	(0.911)	(0.105)	(0.763)	(0.449)	(0.388)	(0.011)	(0.541)	(0.004)	(0.000)		(0.000)
$LISTING_{it}$	0.141	-0.001	0.011	-0.085	0.033	-0.055	0.092	0.038	0.074	0.508	0.153	1.000
	(0.000)	(0.969)	(0.763)	(0.016)	(0.351)	(0.120)	(0.009)	(0.448)	(0.143)	(0.000)	(0.000)	

Table A.4 exhibits the pair wise Pearson correlation coefficients in the lower left triangle. Pair wise Spearman correlation coefficients are provided in the upper right triangle. Significance levels are reported below in parenthesis.

Table A.5: Panel probit regression results

		Model 1	Model 2 (including MC)	Model 3 (including EBB)
	Predicted Sign	Coefficient (Z-Statistic) N=805	Coefficient (Z-Statistic) N=412	Coefficient (Z-Statistic) N=400
CONSTANT	+/-	-8.219***	-7.228***	-9.0137***
		(-6.95)	(-4.89)	(-4.02)
IMPAIRMENT				
INCOME_{it}	-	-5.251***	-3.842***	-9.763***
		(-6.39)	(-3.92)	(-4.16)
OCF_{it}	-	1.070	0.531	-0.128
		(1.35)	(0.55)	(-0.10)
MTB_{it}	-	0.071*	0.045	0.162*
		(1.79)	(0.93)	(1.73)
REPORTING INCENTIVES				
BIGBATH_{it}	-	0.491	-1.183	-3.966
		(0.46)	(-0.90)	(-1.14)
INCSMOOTH_{it}	+	2.785***	1.872**	6.879***
		(4.15)	(2.32)	(3.21)
DTA_{it}	-	0.004	0.005	-0.014
		(0.66)	(0.53)	(-1.10)
MC_{it}	+	–	0.245	–
		–	(1.07)	–
EBB_{it}	+	–	–	-0.685
		–	–	(-1.58)
CONTROL VARIABLES				
FIRMSIZE_{it}	+	0.574***	0.463***	0.643***
		(6.57)	(4.46)	(3.97)
BIG4_{it}	+	0.323	0.992**	0.895
		(1.07)	(2.04)	(1.58)
LISTING_{it}	+	-0.755*	-0.579	-0.998
		(-1.69)	(-1.31)	(-1.63)
Log Likelihood		-382.710	-188.209	-171.619
Wald-statistic		0.000	0.000	0.001
Percent correctly predicted		0.709	0.684	0.699
McFadden‘s Pseudo R^2		0.292	0.272	0.329

Table A.5 shows the panel probit regression results using random effects with clustered robust standard errors. The total sample used in Model 1 consists of 805 firm-year observations. The reduced sample used in Model 2 contains all German companies listed in HDAX between 2004 and 2010 for which a complete Worldscope dataset and sufficient information concerning management changes was available. The sample consists of 412 firm-year observations. The reduced sample used in Model 3 contains all German companies listed in HDAX between 2004 and 2010 for which a complete Worldscope dataset and sufficient information concerning earnings-based bonus payments was available. The sample consists of 400 firm-year observations. Parameter estimates are based on the following models:

Model 1: $\Pr(\mathrm{WO}_{it} = 1) = \beta_0 + \beta_1\mathrm{INCOME}_{it} + \beta_2\mathrm{OCF}_{it} + \beta_3\mathrm{MTB}_{it} + \beta_4\mathrm{BIGBATH}_{it} + \beta_5\mathrm{INCSMOOTH}_{it} + \beta_6\mathrm{DTA}_{it} + \beta_7\mathrm{FIRMSIZE}_{it} + \beta_8\mathrm{BIG4}_{it} + \beta_9\mathrm{LISTING}_{it} + \beta_{10-15}\mathrm{YEAR}_t + \epsilon_{it}$

Model 2: $\Pr(\mathrm{WO}_{it} = 1) = \beta_0 + \beta_1\mathrm{INCOME}_{it} + \beta_2\mathrm{OCF}_{it} + \beta_3\mathrm{MTB}_{it} + \beta_4\mathrm{BIGBATH}_{it} + \beta_5\mathrm{INCSMOOTH}_{it} + \beta_6\mathrm{DTA}_{it} + \beta_7\mathrm{MC}_{it} + \beta_8\mathrm{FIRMSIZE}_{it} + \beta_9\mathrm{BIG4}_{it} + \beta_{10}\mathrm{LISTING}_{it} + \beta_{11-16}\mathrm{YEAR}_t + \epsilon_{it}$

Model 3: $\Pr(\mathrm{WO}_{it} = 1) = \beta_0 + \beta_1\mathrm{INCOME}_{it} + \beta_2\mathrm{OCF}_{it} + \beta_3\mathrm{MTB}_{it} + \beta_4\mathrm{BIGBATH}_{it} + \beta_5\mathrm{INCSMOOTH}_{it} + \beta_6\mathrm{DTA}_{it} + \beta_7\mathrm{EBB}_{it} + \beta_8\mathrm{FIRMSIZE}_{it} + \beta_9\mathrm{BIG4}_{it} + \beta_{10}\mathrm{LISTING}_{it} + \beta_{11-16}\mathrm{YEAR}_t + \epsilon_{it}$

*** ** * denotes significance at <0.01, <0.05, <0.1 levels respectively.

Table A.6: Sensitivity analysis

		Model 1 with ROA$_{it}$	Model 1 with SALES$_{it}$	Model 1 with MTBCHANGE$_{it}$	Model 1 Logit	Model 1 excluding 2005
	Predicted Sign	Coefficient (Z-Statistic) N=805	Coefficient (Z-Statistic) N=805	Coefficient (Z-Statistic) N=805	Coefficient (Z-Statistic) N=805	Coefficient (Z-Statistic) N=721
CONSTANT	+/-	-7.807***	-7.974***	-7.815***	-14.543***	-8.591***
		(-6.64)	(-6.49)	(-6.76)	(-6.77)	(-6.68)
IMPAIRMENT						
INCOME$_{it}$	-	–	-4.908***	-5.06***	-9.918***	-5.227***
		–	(-6.10)	(-6.09)	(-6.07)	(-6.05)
ROA$_{it}$	-	-0.048***	–	–	–	–
		(-5.24)	–	–	–	–
OCF$_{it}$	-	0.824	–	1.34*	1.899	0.934
		(1.05)	–	(1.69)	(1.34)	(1.11)
SALES$_{it}$	-	–	(-0.880)	–	–	–
		–	(-0.58)	–	–	–
REPORTING INCENTIVES						
MTB$_{it}$	-	0.055	0.082**	–	0.135*	0.063
		(1.39)	(2.02)	–	(1.86)	(1.54)
MTBCHANGE$_{it}$	+	–	–	-0.027	–	–
		–	–	(-0.33)	–	–
BIGBATH$_{it}$	-	(0.581)	(0.599)	0.318	0.977	0.309
		(0.53)	(0.56)	(0.30)	(0.50)	(0.28)
INCSMOOTH$_{it}$	+	2.255***	2.640***	2.912***	5.635***	2.871***
		(3.40)	(3.93)	(4.33)	(4.03)	(4.14)
DTA$_{it}$	-	0.100	0.004	0.005	0.006	0.004
		(1.53)	(0.60)	(0.79)	(0.54)	(0.54)
CONTROL VARIABLES						
FIRMSIZE$_{it}$	+	0.542***	0.570***	0.551***	1.015***	0.602***
		(6.26)	(6.43)	(6.41)	(6.42)	(6.31)
BIG4$_{it}$	+	0.371	0.322	0.371	0.587	0.369
		(1.21)	(1.06)	(1.23)	(1.11)	(1.17)
LISTING$_{it}$	+	-0.693	-0.765*	-0.741*	-1.345*	-0.912*
		(-1.53)	(-1.70)	(-1.66)	(-1.70)	(-1.93)
Log Likelihood		-390.960	-383.465	-384.417	-381.662	-343.635
Wald-statistic		0.000	0.000	0.000	0.000	0.000
McFadden's Pseudo R^2		0.277	0.291	0.289	0.294	0.290

Table A.6 shows our sensitivity analysis. We based our sensitivity tests on our model 1 with a sample size of 805 firm-year observations. The exclusion of 2005 reduces the sample to 721 firm-years. Parameter estimates are based on model 1 described in Table A.5 with the variations indicated in the header of the table.
*** ** * denotes significance at <0.01, <0.05, <0.1 levels respectively.

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3 What Drives Companies? An Analysis of Fixed Asset Write-Offs in Europe in the Context of Different Institutional Settings

Chapter contents

What Drives Companies? An Analysis of Fixed Asset Write-Offs in Europe in the Context of Different Institutional Settings

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Abstract Based on a sample of 1,300 companies from the EU15 member states, this study examines the factors that influence fixed asset write-offs in Europe. Using the Cragg model for the corner solution outcome of asset write-offs we are able to separately analyze the determinants of the write-off decision and of the write-off magnitude. We show that in general the write-off decision seems to be driven by asset impairment while the write-off magnitude seems to be driven by earnings management. Further analyses are conducted of the write-offs separated into country clusters. We cannot confirm our assumption that earnings management decreases with greater investor protection, but we show that companies from 'outsider economies' use income smoothing and big bath accounting to determine the write-off magnitude. We do not find such clear patterns for 'insider economies', but nevertheless we are still able to show that it does not seem to be asset impairment alone that drives asset write-offs. By partitioning our sample period into two sub-periods we can additionally show that the processes that determine write-offs become more similar for 'outsider economies' and 'insider economies with strong enforcement', while those of 'insider economies with weak enforcement' change individually. We see that the influence of asset impairment seems to decrease over time.

3.1 Introduction

Since the adoption of the *IAS Regulation* (EC Regulation No. 1606/2002) all European publicly listed companies are required to prepare their consolidated financial statements in accordance with *International Financial Reporting Standards* (IFRS). The aim of the mandatory adoption of IFRS has been to harmonize financial reporting in order to ensure a high degree of transparency and comparability. However, the introduction of uniform accounting standards does not necessarily result in uniform financial reporting (*Ball* (2006)). Financial reporting (quality) is rather influenced by a set of local factors like politics and enforcement that do not converge simultaneously with the introduction of IFRS. It is therefore likely that national patterns persist over time (*Kvaal* and *Nobes* (2012)). Different accounting practices can easily evolve when accounting choices exist and when accounting regulations are based on fair value accounting. Fair value accounting requires managerial judgment and therefore always entails managerial discretion. How this discretion is used by managers is influenced by the national setting in which these managers operate. The result is that despite the mandatory introduction of IFRS financial reporting practice is not the same in all countries applying international standards, but differs depending on their institutional background (*Kvaal* and *Nobes* (2012)).

IFRS are a globally accepted set of accounting standards involving a huge extent of fair value accounting, which for most European countries implied a change in their overall accounting regime. One important international regulation that incorporates fair value accounting is IAS 36 *Impairment of Assets*, which governs when and by which amount fixed assets have to be written off. *Kvaal* and *Nobes* (2012) classify the tendency to write off as an IFRS practice for which national differences are difficult to measure. This study examines the factors that determine the write-offs of European publicly listed companies. By segmenting the companies into three country clusters in accordance with *Leuz*, *Nanda* and *Wysocki* (2003) we are able to analyze the influence of the institutional setting in which the companies operate. Prior studies that examine the impairment of assets have mainly focused on the US-American (e.g. *Riedl* (2004); *Beatty* and *Weber* (2006)) or Australian markets (e.g. *Cotter*, *Stokes* and *Wyatt* (1998); *Minnick* (2011)). Only sporadic work has been done concerning some countries in the European market (e.g. *AbuGhazaleh*, *Al-Hares* and *Roberts* (2011); *Garrod*, *Kosi* and *Valentincic* (2008)), and to the best of our knowledge there has been no study on write-offs across Europe. Thus, in contrast to the existing literature our study incorporates companies from different countries with different institutional settings, giving us the opportunity to analyze the influence of institutional factors on write-offs.

Our sample comprises 1,300 companies from the EU15 countries, and our period of analysis covers the years 2005 to 2011 inclusive. To analyze the factors that influence the write-off decision and the write-off magnitude a corner solution model has to be applied. Previous studies largely used the Tobit model (e.g. *Riedl* (2004); *AbuGhazaleh*, *Al-Hares* and *Roberts* (2011)). We compare two well-known models – namely the Tobit model (*Tobin* (1958)) and the Cragg model (*Cragg* (1971)) – and find that the more general Cragg model fits better. One advantage of the Cragg model is that it analyzes the factors influencing the write-off decision separately from the factors influencing the write-off magnitude, while the Tobit model assumes that all factors have the same influence on both aspects. Applying the Cragg model we find, for example, that big bath accounting and income smoothing help to explain the write-off magnitude but have no influence on the write-off decision.

To analyze the influence of different institutional settings we estimate the regression separately within three country clusters: ‘outsider economies’, ‘insider economies with strong enforcement’, and ‘insider economies with weak enforcement’ (*Leuz*, *Nanda* and *Wysocki* (2003)). We find that the write-off decision of companies in 'outsider economies' is mainly driven by asset impairment while the write-off magnitude is significantly influenced by earnings management. For the 'insider economies' we find no clear pattern of earnings management but can still show that write-offs are not solely driven by firm performance. To examine whether the processes that drive asset write-offs become more similar across these country clusters over time, we partition our sample into two periods and run the regression for all clusters for both periods. We find that the write-off practices of countries in 'outsider economies' and 'insider economies with strong enforcement' become more similar while the determinants that drive write-offs in 'insider economies with weak enforcement' change somewhat individually. Additionally, we find that the influence of asset impairment decreases over time.

This paper contributes to the existing literature in three ways. First, we introduce an alternative to the Tobit model which currently seems to be the standard solution for the analysis of write-offs. In this study we contrast the Cragg model and the Tobit model and find that the Cragg model outperforms the Tobit model. Additionally, the Cragg model allows the write-off decision and the write-off magnitude to be analyzed separately, which is an important advantage compared with the Tobit model. Second, we analyze the European market, which until now has been a comparatively under-researched market with regard to fixed asset write-offs. A number of studies have been conducted on the US-American market and on the Australian market, but the implementation of accounting standards materially depends on institutional factors. Thus, findings from US-American or Australian studies cannot be assumed to apply to the European market without further investigation. This is complicated by the fact that different accounting standards are employed in the mentioned markets. Finally, we analyze the processes that drive fixed asset write-offs for three country clusters and compare the processes for two time periods. We can show that systematic differences between write-offs in 'outsider economies' and 'insider economies with strong enforcement' diminish and that the processes driving write-offs in these two clusters become more similar, while 'insider economies with weak enforcement' develop independently. This finding emphasizes the importance of enforcement for the implementation of accounting standards.

The results of our study should be of interest to standard setters, national enforcement agencies and users of financial statements. With the mandatory adoption of IFRS, a good first step towards uniform financial reporting within the EU has been taken. Nevertheless, as our results show, there still remains a lot of work to do since different incentives exist across the member states due to different institutional settings. Thus, uniform enforcement of IFRS across Europe is the necessary next step to achieve uniform financial reporting. Until that point is reached, financial statement users ought to avoid assuming that financial reporting is consistent across national borders; instead they should consider national differences where applicable if financial statements are compared.

The remainder of this study is organized as follows. In section 3.2 we give a short introduction to IAS 36 and discuss the existing literature. In section 3.3 the development of hypotheses is presented. In section 3.4 we describe the research design. In section 3.5 descriptive statistics and regression results are displayed, while section 3.6 shows some further analyses. We discuss the robustness of our results and some limitations in section 3.7 and outline our conclusions in 3.8.

3.2 Background

3.2.1 Impairment of Assets According to IAS 36

IAS 36 requires annual impairment testing of all assets that are not explicitly excluded from the scope of the regulation. IAS 36 applies mainly to property, plant and equipment and intangible assets including goodwill. The principal requirement is that all assets must be tested for impairment separately, but if an asset does not generate cash flows that are largely independent of those from other assets, the asset's cash-generating unit is subjected to a quantitative impairment test.

Impairment testing according to IAS 36 involves two steps. The first – qualitative – step is the determination of whether an indication exists that the asset under consideration is impaired. This step requires qualitative and quantitative reviews of changes in the market environment, the company's business activities and the nature of the asset itself. In the second – quantitative – step the recoverable amount of the asset under consideration has to be compared to the book value. If the book value exceeds the recoverable amount the asset is said to be impaired and has to be written off to the recoverable amount. The recoverable amount is defined as the higher of the fair value less costs to sell and the value in use. The fair value less costs to sell is optimally derived from an existing sales agreement or from prices on an active market. If such values do not exist the fair value less costs to sell can be calculated based on valuation methods such as the discounted cash flow approach, considering only those cash flows that could be generated from the use of the asset by an external third party. The value in use is the present value of future cash flows expected to be derived from the further use and disposal of the asset. Here, those cash flows that the company expects have to be used; hence, synergies may play an important role in the determination of the value in use.

For some assets that are not (yet) depreciated – namely goodwill, intangible assets with an indefinite useful life and intangible assets that are not yet available for use – the recoverable amount additionally has to be compared to the book value at one arbitrary but fixed point in the year, irrespective of whether an indication for impairment exists. By definition, goodwill does not generate cash flows that are largely independent of those from other assets, and accordingly it always has to be allocated to a cash-generating unit to be tested for impairment. If the recoverable amount of the cash-generating unit falls below its book value the resulting impairment loss has to be assigned to goodwill first. Only after goodwill is completely written off is the remaining impairment loss assigned to the other assets in the cash-generating unit.

Even though the regulations for the impairment of assets appear quite detailed they are still based on management estimations, creating space for managerial discretion. Moreover, it is not only the estimation of fair value but also the calculation of value in use – from the construction of cash-generating units up to the prediction of future cash flows and the choice of an appropriate discount rate – that require managerial decisions. What incentives influence these decisions is largely influenced by institutional factors. For this reason we aim to analyze which accounting practices prevail in Europe regarding the impairment of assets.

3.2.2 Prior Research

3.2.2.1 Asset Write-Offs

The first area of the existing literature that is of importance for our paper relates to the determinants of fixed asset write-offs. As mentioned above, until now research has mainly concentrated on the US-American and Australian markets. Pioneering work has been done by a number of authors who provided early evidence of the factors influencing the timing and amount of write-offs in the USA before the adoption of a specific accounting regulation concerning the impairment of long-lived assets. *Strong* and *Meyer* (1987) emphasize the influence of tax considerations on the write-off decision and assert that write-offs are recorded in periods with higher marginal tax rates and when new investment opportunities exist – hence in periods with improving operating environments. They show that write-off companies are neither the strongest nor the weakest firms in their industry with regard to performance measures, and that write-offs are associated with low financial performance but also with a recent improvement in operating performance. Additionally, they find that write-offs are more frequent if a change in senior management has occurred.

Elliott and *Shaw* (1988) analyze only material, separately disclosed write-offs (big bath). They find that companies that disclose these discretionary write-offs are larger than the average company in their industry and have underperformed in the preceding three years. They also find that these companies frequently experience management changes. By comparing expected earnings to the pre-write-off earnings, *Zucca* and *Campbell* (1992) analyze the extent to which earnings management drives the amount and timing of write-offs and find that both big bath accounting and income smoothing are significant drivers of this decision. In contrast, *Rees*, *Gill* and *Gore* (1996) test for earnings management by focusing on abnormal accruals made concurrently with asset write-offs. They find that managers use discretion in the write-off decision to provide value-relevant signals to investors.

Francis, *Hanna* and *Vincent* (1996) use a Tobit model to analyze the influence of firm performance and management incentives on the write-off decision. They find that the return of the preceding years has a significant negative influence and the occurrence of a management change has a significant positive influence on write-offs. Contrary to their expectations, they find a significant positive correlation between write-offs and unusually poor earnings and a significant negative correlation between write-offs and unusually good earnings, meaning that neither income smoothing nor big bath accounting is applied. To further analyze the influence of management incentives they separately analyze write-offs of goodwill, inventory, and property, plant and equipment and restructurings. Consistent with their expectations, they find that incentives are more significant in explaining goodwill write-offs and restructurings than in explaining write-offs of inventory and property, plant and equipment.

Riedl (2004) uses a Tobit model to compare the determinants of the write-off decision before and after the adoption of *Statement of Financial Accounting Standard* (SFAS) 121 *Accounting for the Impairment of Long-Lived Assets and for Long-Lived Assets to be Disposed of.* He shows that write-offs are less associated with economic factors and more associated with earnings management in the post-SFAS 121 setting. *Beatty* and *Weber* (2006) examine the SFAS 142 *Goodwill and Other Intangible Assets* adoption decision. In the adoption period companies were allowed to record a one-time loss below the line as opposed to the uncertain recognition of future above-the-line write-offs of goodwill. The authors analyze which factors influence the recognition of a one-time loss below the line in two steps. First, they apply a probit model to analyze the factors influencing the decision to recognize a below-the-line loss and second, they carry out a censored regression to analyze the factors influencing the amount of goodwill that is written off. They find that contracting incentives, market incentives, CEO tenure and exchange listings affect the decision regarding whether a one-time loss below the line is recorded.

On the Australian market, *Cotter*, *Stokes* and *Wyatt* (1998) analyze the determinants of write-offs based on an ordinary least squares regression. Disregarding firm performance, they find that riskier companies, companies with a higher capacity to absorb write-offs and companies with more management changes report higher write-offs. The authors use higher cash reserves and lower leverage as proxies for the capacity to absorb write-offs. *Minnick* (2011) uses a probit model to focus on the influence of corporate governance on the write-off decision and finds that better governed companies record impairments more often and that poorly governed companies use write-offs opportunistically. Using an ordinary least squares regression to analyze the determinants of the write-off magnitude, she additionally finds that well governed companies realize significantly lower write-offs.

As already mentioned, not much work has been done yet concerning the European market. *Garrod*, *Kosi* and *Valentincic* (2008) analyze the factors influencing fixed and current asset write-offs in small private companies in Slovenia. Outside the setting of large publicly listed companies, their examination takes place in the absence of all agency issues except for the information asymmetry between the company and the tax authority. Employing a logit model to examine the determinants of the write-off decision they find that current asset write-offs are driven by discretion while fixed asset write-offs follow regulatory and accounting process issues linked to asset impairment. Using a linear regression to analyze the drivers of the write-off magnitude they find that more profitable firms write off higher amounts – contrary to the accounting standard requirements. *AbuGhazaleh*, *Al-Hares* and *Roberts* (2011) examine the drivers of goodwill write-offs in the United Kingdom after the implementation of IFRS 3, which abandoned goodwill amortization and introduced the impairment-only approach. The authors elaborate extensively on the influence of different corporate governance variables on goodwill write-offs, and finally conclude that managers use discretion concerning the goodwill write-off to convey private information.

In summary, these studies find that managerial incentives are important in understanding write-offs. The authors analyze the influence of different factors in different institutional settings, but they all show that write-offs are not solely driven by asset impairment; rather, write-offs are also used to manage earnings.

3.2.2.2 Further Important Literature

Researchers have tried to classify countries according to certain similarities for a long time. The *American Accounting Association* (1977) criticized the lag of comparative accounting behind other research and proposed a morphology for the classification of accounting systems based on a wide range of factors, such as the political and economic system, the objective of financial reporting and the source of authority for the accounting standards. *Frank* (1979) examines the extent of use of 233 accounting principles in 38 countries, and categorizes them as 'British Commonwealth countries', 'Latin American countries', 'Continental European countries' and 'US-influenced countries'. In a similar attempt, *Nair* and *Frank* (1980) test whether these categories are robust over time and with a disaggregation of the accounting practices in measurement and disclosure. The authors find that they are not, and conclude that previous results may be invalid.

Nobes (1983) proposes four country clusters for the countries of the 'developed Western world' as determined in 1980. This classification system includes factors like the type of users of the published accounts and the importance of tax rules. In a later study, *Nobes* (1998) proposes to differentiate companies according to their country's type of culture and the strength of the equity outsider system. Similarly, *Leuz*, *Nanda* and *Wysocki* (2003) use a descriptive cluster analysis based on nine institutional factors drawn from *La Porta*, *Lopez-de-Silanes* and *Shleifer* (1997) and *La Porta*, *Lopez-de-Silanes* and *Shleifer* (1998) to identify three country clusters that are similar with respect to these institutional factors – namely 'outsider economies', 'insider economies with strong enforcement' and 'insider economies with weak enforcement'. Investor protection decreases from the first to the last cluster, and the authors show that the influence of earnings management correspondingly increases from the first to the last. For our country cluster analyses we will use the country clusters proposed by *Leuz*, *Nanda* and *Wysocki* (2003) as they were constructed for an analysis of earnings management, which is the closest match with our analysis.

The aim of the mandatory adoption of IFRS has been to harmonize financial reporting. However, it is now popularly accepted that the introduction of common accounting regulations does not suffice to reach uniformity in accounting practices. *Ball* (2006) states that uniform accounting practices do not necessarily follow from uniform accounting standards because accounting practices depend on economic and political forces. *Schipper* (2005) argues that uniform reporting practices across the EU can only be achieved if the *International Accounting Standards Board* (IASB) provides detailed implementation guidance and if a single European enforcement body is created. She additionally underlines the fact that the institutional settings that materially influence the financial reporting incentives differ significantly across the EU member states. *Kvaal* and *Nobes* (2010) analyze the accounting policies of large listed companies from Australia, France, Germany, Spain and the United Kingdom in 2005/2006 and find that choices among IFRS policy options can largely be explained by the continuation of pre-IFRS policies. *Kvaal* and *Nobes* (2012) compare the policies of 2005/2006 with those of 2008/2009 to see whether the influence of the pre-IFRS policies decreases. They find that while changes in the continental European countries mainly lead to divergence from pre-IFRS policies, the national patterns still persist. These studies show that harmony has not been achieved yet. They conclude that "the lack of comparability reduces the decision-usefulness of the accounting numbers and hampers the realization of the rewards of accounting harmonization" (*Kvaal* and *Nobes* (2012), p. 368).

Vast quantities of research have been conducted regarding earnings management. Good literature reviews are provided by *Schipper* (1989) and *Healy* and *Wahlen* (1999). For our further analyses we define earnings management in accordance with *Healy* and *Wahlen* (1999) as the attempt to manage financial reports in order to influence either contractual outcomes or stakeholders' perceptions of the underlying economic performance.

3.3 Hypothesis Development

3.3.1 Overall Considerations

Similar to *Riedl* (2004), we assume that write-offs are influenced by both asset impairment and management incentives. Following *Leuz*, *Nanda* and *Wysocki* (2003) we assume that management incentives will be more important in countries with low investor protection while asset impairment prevails in countries with high investor protection.

3.3.2 Impairment

Following the requirements of IAS 36 a write-off has to be recorded when the asset under consideration is impaired. An asset is said to be impaired when its recoverable amount exceeds its book value; the magnitude of the write-off equals the difference between these two amounts. *Cotter*, *Stokes* and *Wyatt* (1998) outline a number of incentives for the management – namely signaling, contracting and compliance incentives – to comply with the regulations and record a write-off when there are impaired assets. Thus, measuring the correlation of the existence and amount of impaired assets, as well as the occurrence and amount of write-offs, would be fairly simple if the required data were available. However, neither the management's expectations on which the calculation of the recoverable amount is based nor other information at the asset level is available. Hence we have to find another proxy for the existence of impaired assets.

Following prior studies (*Riedl* (2004); *Beatty* and *Weber* (2006); *Francis*, *Hanna* and

Vincent (1996)) we assume that the probability that a firm has impaired assets and the amount by which these assets are impaired depend on the overall firm performance. The assumption that companies have an incentive to record a write-off when there are impaired assets leads to our first two hypotheses:

H1a: The probability of write-offs rises with decreasing firm performance.

H1b: The magnitude of recorded write-offs rises with decreasing firm performance.

Prior research has proven that not only the performance of the company itself but also the performance of the industry of the company influences the write-off of fixed assets (*Riedl* (2004); *Francis*, *Hanna* and *Vincent* (1996)). Assuming that companies that operate in an industry with worse performance are more susceptible to asset impairment, we obtain our next two hypotheses:

H2a: The probability of write-offs rises with decreasing performance within the firm's industry.

H2b: The magnitude of recorded write-offs rises with decreasing performance within the firm's industry.

3.3.3 Reporting Incentives

3.3.3.1 Capital Market Incentives

Financial statements are an important source of information for (potential) shareholders, which may lead to an incentive for management to manipulate earnings to influence the short-term stock price performance (*Healy* and *Wahlen* (1999)). Prior research on the determinants of write-offs has found evidence of income smoothing (*Zucca* and *Campbell* (1992); *AbuGhazaleh*, *Al-Hares* and *Roberts* (2011)) and big bath accounting (*Zucca* and *Campbell* (1992); *Riedl* (2004); *AbuGhazaleh*, *Al-Hares* and *Roberts*

(2011)). Income smoothing occurs whenever the management tries to reduce earnings fluctuation. According to *Trueman* and *Titman* (1988), income smoothing reduces the stakeholders' volatility estimates, which reduces their assessment of bankruptcy risk; this in turn increases the stock price. On the other hand, big bath accounting describes the management's decision to delay loss recognition to a period in which earnings are unexpectedly low, and then to realize a large one-time loss. *Strong* and *Meyer* (1987) describe several advantages of big bath accounting. First, the recognition of a large write-off signals that past problems have been addressed, which is intended to result in a positive capital market reaction to the write-off. Second, by making good on previously delayed losses and anticipating future losses, a reserve for future periods is created. Finally, realizing a one-time loss ensures high returns for future periods. *Walsh*, *Craig* and *Clarke* (1991) additionally argue that worsening an already bad situation may have only limited additional impact.

While the coexistence of big bath accounting and income smoothing may be counter-intuitive, *Kirschenheiter* and *Melumad* (2002) present a model in which both strategies are part of one equilibrium reporting strategy. They prove that the firm value is maximized if managers reduce reported earnings when a positive earnings surprise occurs to increase the inferred precision. If there is a negative earnings surprise the manager will also reduce earnings to decrease the inferred precision, which in turn reduces the effect of the negative earnings. Applied to asset write-offs, this means that the probability and magnitude of reported write-offs rises for unexpectedly low and unexpectedly high earnings. This gives rise to our next hypotheses:

H3a: The probability of write-offs rises for unexpectedly high and unexpectedly low earnings.

H3b: The magnitude of recorded write-offs rises for unexpectedly high and unexpectedly low earnings.

3.3.3.2 Contracting Incentives

There are different types of contracts that may influence write-offs. In this study we concentrate on debt contracts. *Watts* and *Zimmerman* (1990) expound the debt/equity hypotheses that higher leverage proxies for the closeness to debt covenant restrictions. This in turn results in management's choice of income-increasing accounting methods. This assumption is based on the condition that the leverage can be used to proxy for the closeness to debt covenant restrictions. Empirical evidence confirming this assumption has been provided by *Duke* and *Hunt* (1990), who prove that various proxies for leverage can be used to proxy for the existence of and closeness to debt covenant restrictions. *Sweeney* (1994) analyzes a set of companies over the years prior to a debt covenant violation and shows that managers of firms that are close to a violation of debt covenant restrictions are more likely to adopt income-increasing accounting methods. The arguments above entail the assumption of a negative relationship between leverage and asset write-offs. Results consistent with these arguments have been obtained in other studies (*Riedl* (2004); *Beatty* and *Weber* (2006)).

In contrast, high leverage could also result in increased monitoring by creditors (especially banks), who enforce the recognition of a write-off when assets are impaired (*Cotter*, *Stokes* and *Wyatt* (1998)). This argument entails the assumption of a positive correlation between write-offs and leverage. As it is not clear which of these influences prevails we do not assume a direction for the influence of leverage on write-offs:

H4a: The probability of write-offs is influenced by leverage.

H4b: The magnitude of recorded write-offs is influenced by leverage.

3.4 Research Design

3.4.1 Sample Selection

We base our analysis on companies domiciled in one of the EU15[1] member states. To identify the companies we used the Thomson Reuters Global Equity Indices[2] for the countries under consideration. We drew our data from the Worldscope database. Table B.1 presents the process of sample selection.

(Table B.1 about here)

We start our analysis with a total sample of 1,893 companies and 15,144 firm-year observations. 23 companies and 184 firm-year observations belong to companies from countries outside the EU15 and are therefore excluded from the sample. Following prior studies we additionally exclude finance, insurance and real estate companies (Standard Industrial Classification (SIC) codes 6000-6999), which reduces our sample by a further 490 companies and 3,920 firm-years. Furthermore, we had to exclude 78 companies and 3,765 firm-year observations due to incomplete datasets. Finally, there were only two companies with seven firm-years remaining in the industry Public Administration; we excluded these observations to be able to analyze industry effects later on. Our sample selection results in a final sample of 1,300 companies with a total of 7,268 firm-year observations. Panels B to D of Table B.1 describe the sample. France, Germany and the United Kingdom make up the largest part of the sample, which is in line with the

[1] EU15 refers to the member states of the EU until April 2004: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

[2] The Thomson Reuters Global Equity Indices aim to contain representative samples of each stock market covering 75-80 % of total market capitalization. For more information see `http://thomsonreuters.com/content/financial/pdf/i_and_a/indices/datastream_global_equity_manual.pdf` (website last accessed at October 16th, 2012).

size of the respective capital markets. We defined the industries according to the SIC code divisions.[3] Looking at the industry classification as depicted in Panel C we see that almost half of our sample firms belong to the sector 'Manufacturing'. The sectors 'Services' and 'Transportation, Communications, Electric, Gas, And Sanitary Services' are represented with 222 and 179 companies respectively, while for all other sectors we have fewer than 100 firms within our sample.

A write-off has been recognized in 957 companies and in 3,269 firm-years within our sample, resulting in 343 companies which did not record a write-off within the whole sample period from 2005 to 2011. Interestingly, in more than two-thirds of the write-off firm-years a write-off of property, plant and equipment has been realized, while a write-off of goodwill and other intangible assets has been recorded in only slightly more than one-third of the write-off firm-years. In some firm-year observations more than one type of write-off has been recorded; thus, the numbers of companies and firm-years do not add up to all write-off numbers.

3.4.2 Country Clusters

To analyze systematic differences in the accounting of write-offs across the EU15 member states due to different institutional settings, we partition our sample into three country clusters. Following *Leuz*, *Nanda* and *Wysocki* (2003) our three clusters are 'outsider economies' (due to the restriction to the EU15 member states this cluster contains only the United Kingdom), 'insider economies with strong enforcement', and 'insider economies with weak enforcement'. Table B.2 displays the allocation of coun-

[3]Prior studies use two-digit or four-digit SIC codes (*Riedl* (2004); *Francis*, *Hanna* and *Vincent* (1996)). We used the SIC code divisions to prevent the inclusion of industries with too few observations.

tries to the country clusters.[4]

(Table B.2 about here)

'Outsider economies' are characterized by large stock markets, dispersed ownership, strong investor rights, and strong legal enforcement. 'Insider economies' have less well-developed stock markets and concentrated ownership, and are further distinguished by the strength of their legal enforcement. Following the argumentation of *Leuz*, *Nanda* and *Wysocki* (2003), insiders try to use earnings management to conceal the firm's performance from outsiders. This is only possible when outsiders are not effectively protected. Investor protection increases from cluster 1 to cluster 3; hence, we assume that the impact of asset impairment on write-offs decreases from cluster 1 to cluster 3 while the impact of earnings management increases.

3.4.3 Model Choice

One important feature of data on write-offs that should not be neglected is that they are limited dependent. Asset write-offs are continuously distributed over positive values but there is a positive probability of zero write-offs. This kind of data could result from either censoring or a corner solution response. Data censoring means that we cannot observe the actual outcome of the dependent variable but we observe a censored version instead. Hence the positive probability of the dependent variable taking one specific value is artificial, following from the process of data collection. Here, we do not have a data censoring problem. For asset write-offs we do observe the real write-off values, but

[4]As *Leuz*, *Nanda* and *Wysocki* (2003) did not include Luxembourg in their analysis we could not allocate it to one of the three clusters and hence excluded the respective observations from this analysis. The whole sample comprises only 52 firm-years from Luxembourgian companies. Nevertheless, including Luxembourg in the cluster 'insider economies with strong enforcement' (untabulated) does not change our results materially.

there is still a non-trivial fraction of outcomes that takes the value zero – because the company did not recognize a write-off, not because we observe censored data. Hence, a corner solution model has to be applied.

In prior research on write-offs, the Tobit model has often been applied (*Riedl* (2004), *AbuGhazaleh*, *Al-Hares* and *Roberts* (2011)). To our knowledge *Beatty* and *Weber* (2006) are the only authors that use a two-step model, estimating a joint probit and censored regression. Interestingly, none of the authors explain why the respective model has been chosen or test their choice against an alternative model. We contrast two models that can be applied to corner solution data: the Tobit model and the more general Cragg model. Good overviews of the models that can be applied to limited dependent variables are given by *Amemiya* (1984) and *Wooldridge* (2010). The Tobit model was introduced by *Tobin* (1958) for the analysis of limited dependent variables. In an example he analyzed the relationship of durable goods expenditure with age and liquid asset holdings. The model has only one stage and estimates the effects on the write-off decision and on the write-off magnitude simultaneously. The most appealing feature of the Tobit model – its ease of implementation due to the one-step approach – is at the same time its most important limitation. From the one-step approach it follows that the partial effects of one explanatory variable on the probability to write off and on the expected write-off magnitude must have the same sign. Additionally, the relative effects of two continuous independent variables on the write-off probability and on the expected write-off magnitude are identical (*Wooldridge* (2010)).

A model that is more flexible is the Cragg model, which allows different processes to determine the participation decision (if a write-off is recorded) and the amount decision (what magnitude is written off, if there is a write-off). These two decisions should not be confused with the two steps of the impairment test according to IAS 36, i.e. the qualitative and quantitative impairment tests. Here we assume that managers first decide whether they want to or have to recognize a write-off and afterwards decide on the magnitude of the write-off. The Cragg model was introduced by *Cragg* (1971), who wanted to extend the Tobit model to apply it to situations where the determination of the size of the variable when it is positive depends on different parameters or variables than the determination of the probability that it is non-zero. As a result, he shows that the Tobit model is nested in his more general model. Like *Tobin* (1958) he applies his model to the purchase of consumer durable goods. Applied to our analysis the models take the following form (in the latent variable formulation):[5]

Tobit model

$$\begin{aligned} |WO_{it}^{T*}| &= \beta_0^T + \beta_1^T roa_{it} + \beta_2^T ocf_{it} + \beta_3^T mtb_{it} \\ &\quad + \beta_4^T ind\_roa_{it} + \beta_5^T ind\_ocf_{it} + \beta_6^T ind\_mtb_{it} \\ &\quad + \beta_7^T BigBath_{it} + \beta_8^T IncSmooth_{it} + \beta_9^T dta_{it} \\ &\quad + \beta_{10}^T \Delta gdp_{it} + \beta_{11}^T size_{it} + \beta_{12}^T big4_{it} \\ &\quad + \beta_{13}^T wo\_prev_{it} + \beta_{14}^T WO\_prev_{it} + \beta_{15-20}^T Year_t + \epsilon_{it} \\ WO_{it}^T &= max(0; |WO_{it}^{T*}|) \end{aligned} \tag{3.4.1}$$

[5]Even though we use a latent variable formulation, here we are interested in WO_{it} and not in WO_{it}^*.

Cragg model

$$
\begin{aligned}
Pr(wo_{it}^{C}=1) = {} & \beta_0^C + \beta_1^C roa_{it} + \beta_2^C ocf_{it} + \beta_3^C mtb_{it} \\
& + \beta_4^C ind\_roa_{it} + \beta_5^C ind\_ocf_{it} + \beta_6^C ind\_mtb_{it} \\
& + \beta_7^C BigBath_{it} + \beta_8^C IncSmooth_{it} + \beta_9^C dta_{it} \\
& + \beta_{10}^C \Delta gdp_{it} + \beta_{11}^C size_{it} + \beta_{12}^C big4_{it} \\
& + \beta_{13}^C wo\_prev_{it} + \beta_{14}^C WO\_prev_{it} + \beta_{15-20}^C Year_t + \epsilon_{it}^C \\
|WO_{it}^{C*}| = {} & \gamma_0^C + \gamma_1^C roa_{it} + \gamma_2^C ocf_{it} + \gamma_3^C ind\_roa_{it} + \gamma_4^C ind\_ocf_{it} \\
& + \gamma_5^C BigBath_{it} + \gamma_6^C IncSmooth_{it} + \gamma_7^C dta_{it} \\
& + \gamma_8^C \Delta gdp_{it} + \gamma_9^C size_{it} + \gamma_{10}^C big4_{it}^C \\
& + \gamma_{11}^C WO\_prev_{it} + \gamma_{12-17}^C Year_t + \zeta_{it}^C \\
WO_{it}^C = {} & wo_{it}^C \cdot |WO_{it}^{C*}|
\end{aligned}
\tag{3.4.2}
$$

Variable definitions are given in Table B.3.

(Table B.3 about here)

The variable of interest in both models is the natural logarithm of the amount of fixed asset write-offs of company i in t relative to the total assets of company i in the period previous to t, WO_{it}. For the Tobit model this equals the maximum of zero and the value of the latent variable. For the Cragg model it is the result of multiplying the indicator variable wo_{it} by the value of the latent variable. Prior models mostly use the absolute value of company i's write-off in t deflated by total assets (*Riedl* (2004); *Cotter*, *Stokes* and *Wyatt* (1998); *Beatty* and *Weber* (2006)). As neither the absolute value of write-offs nor the deflated value is close to a normal distribution but is extremely skewed to the right, we decided to use the natural logarithm. We still do not obtain a perfect normal distribution, but we are much closer to it than with the absolute or deflated values.[6] Hence, we use the natural logarithm for all write-off amount variables (in later analyses we include the write-off of goodwill, other intangibles and property, plant and equipment). To have our observations left censored we use the absolute value of the relative write-offs as the dependent variable. Defining our dependent variable like this makes the interpretation of our regression results a little difficult, as we will have to expect a negative sign for all variables with a positive influence on the write-off magnitude. Table B.4 gives the rationale for our expected signs.

(Table B.4 about here)

The indicator variable wo_{it} equals 1 when company i recognized a write-off in t and zero otherwise. As the Tobit model follows a one-step approach, we include all test variables in this one stage. We define the Cragg model in such a way that the vector of variables determining the amount decision is a strict subset of the vector of variables determining the participation decision.[7] To test hypothesis 1b we include two proxies for firm performance in our estimation of the write-off magnitude, and to test hypothesis 1a we include one additional proxy in the estimation of the write-off probability. Similar to *Riedl* (2004) we use one accrual-related performance measure (return on assets, roa_{it}) and one cash-related performance measure (operating cash flow, ocf_{it}). This approach is additionally supported by the requirements of IAS 36. IAS 36.14 (b) designates unexpectedly low cash flows as well as unexpectedly low profits as indicators that an asset may be impaired. Furthermore, the cash flow is the basis for the calculation of the value in use. We expect negative signs for both proxies in

[6] The skewness of absolute non-zero write-offs amounts to 18.74, that of non-zero write-offs deflated with previous year total assets amounts to 13.63, and that of the natural logarithm of non-zero write-offs deflated with previous year total assets amounts to only -0.31.

[7] This restriction is not necessary for the Cragg model; different sets of variables can be used to model the participation decision and the amount decision (*Wooldridge* (2010)).

the participation model and positive signs in the magnitude model. For the estimation of the write-off probability, we additionally include a dummy variable indicating a market-to-book ratio below one, mtb_{it}. IAS 36.12 (d) identifies a market-to-book ratio below one as an indicator that the asset under consideration is impaired; hence, we expect that the write-off probability rises if the market-to-book ratio falls below one and thus a positive sign.

Similarly, to test hypothesis 2b we include the industry's mean return on assets, ind_roa_{it}, as an accrual-based performance measure and the industry's mean operating cash flow, ind_ocf_{it}, as a cash-based performance measure in the estimations of the write-off magnitude. To test hypothesis 2a, we additionally include a dummy variable that indicates that the mean market-to-book ratio of i's industry is below the mean market-to-book ratio of all sample companies in the estimation of the write-off probability, ind_mtb_{it}. Similar to our expectations concerning the performance measures at the company level, we expect negative signs for ind_roa_{it} and ind_ocf_{it} and a positive sign for ind_mtb_{it} in the participation decision, and positive signs for ind_roa_{it} and ind_ocf_{it} in the amount decision.

To test hypotheses 3a and 3b, we first calculate an earnings management indicator emi_{it}, similarly to *Francis*, *Hanna* and *Vincent* (1996). We define emi_{it} as the difference between company i's Earnings Before Interest and Taxes (EBIT) before impairment losses in t and company i's previous year EBIT, scaled by previous year total assets of company i. This ratio gives company i's EBIT growth deflated by previous period total assets. We then define $BigBath_{it}$ to equal emi_{it} whenever emi_{it} is lower than the mean of emi_{it} in company i's industry, and zero otherwise. Similarly we define $IncSmooth_{it}$ to equal emi_{it} whenever emi_{it} exceeds the mean of emi_{it} in company i's industry, and zero otherwise. This definition is based on the assumption that the EBIT of each company follows a geometric Brownian motion with the industry's mean EBIT growth as a drift factor, a common assumption in finance research. Hence, the expected growth of company i's EBIT equals the industry's mean EBIT growth; smaller growth stands for unexpectedly low earnings and proxies for big bath accounting and larger growth stands for unexpectedly high earnings and proxies for income smoothing. We expect a positive sign for $IncSmooth_{it}$ and a negative sign for $BigBath_{it}$ on the write-off probability and the opposite signs for the write-off magnitude. To test hypotheses 4a and 4b we include the debt-to-asset ratio of company i in t, dta_{it}, for which we do not predict a sign.

Additionally, to our test variables we include several control variables. Δgdp_{it}[8] represents the change in the gross domestic product of the country company i is domiciled in from the previous period to the present one, and is supposed to capture macroeconomic effects (*Riedl* (2004)). We expect a negative influence for Δgdp_{it} as companies in countries with worse overall performance are supposed to be more susceptible to asset impairments. Following the political cost hypothesis (*Watts* and *Zimmerman* (1990)), we include $size_{it}$ as the natural logarithm of company i's total assets in t and expect a positive sign regarding the write-off probability. *Minnick* (2011) finds that better governed companies recognize write-offs more often and of lower magnitude. We assume that this also holds for firm size, and hence assume a negative influence (and by extension a positive sign) of $size_{it}$ for the write-off magnitude. To account for the effect on write-offs a high quality audit might have we include $big4_{it}$, which is an indicator variable equal to 1 when company i has been audited by a Big Four audit company (PwC, KPMG, Ernst & Young or Deloitte) in t and zero otherwise. Following the same argumentation as for firm size, we expect that an audit by a Big Four audit

[8]Our data on the gross domestic product were obtained from Eurostat `http://epp.eurostat.ec.europa.eu/portal/page/portal/national_accounts/data/main_tables` (website last accessed at October 26th, 2012). We use the gross domestic product at market prices at current prices in millions of Euro and calculated the changes ourselves.

company increases the probability of recognizing a write-off and decreases the write-off magnitude.

Previous research has proven that prior period write-offs increase the probability of future write-offs (*Elliott* and *Hanna* (1996); *Francis*, *Hanna* and *Vincent* (1996)). To control for this effect we include WO_prev_{it} in the participation decision and the amount decision and wo_prev_{it} only in the participation decision. WO_prev_{it} is the natural logarithm of the amount of write-offs company i reported in the period previous to t relative to the total assets at the end of the period previous to t. We do not take the absolute value here; thus, changes in WO_prev_{it} are of the same sign as changes in the absolute value of previous year write-offs. wo_prev_{it} is an indicator variable equal to 1 if company i reported a write-off in the period previous to t and zero otherwise. We expect that the occurrence of a write-off in the previous period increases the probability of a write-off in t. For the magnitude of the previous year write-off we assume that a higher write-off in the previous period decreases the write-off probability and magnitude in the current period. Following *Wooldridge* (2010), we adapt the models to panel data by including a complete set of year dummies ($\beta_{15-20} Year_t$, $\gamma_{12-17} Year_t$). To control for serial correlation we use robust standard errors clustered at the company level.

3.5 Results

3.5.1 Descriptive Statistics

Table B.5 provides descriptive statistics for our sample firm-years. The upper section of Table B.5 depicts the mean, standard deviation, minimum and maximum values and the 25%, 50% and 75% quartiles for the continuous variables, while the lower section shows the mean, standard deviation and the amount of zeros and ones for the indicator variables.

(Table B.5 about here)

We find that in 45% of our sample firm-years a write-off has been realized. A write-off of goodwill and other intangible assets has only been recorded in 16% and 17% respectively of our sample firm-years, while a write-off of property, plant and equipment has been realized in 33% of the sample. Hence, while write-offs, particularly of goodwill, are highly discussed by theoreticians and practitioners equally, write-offs of property, plant and equipment occur more than twice as often as write-offs of goodwill. However, untabulated results for absolute write-offs show that mean absolute total write-offs amount to €39 million. The mean absolute write-offs of goodwill, other intangible assets and property, plant and equipment amount to €18 million, €6 million and €14 million respectively, showing that write-offs of goodwill are (as a mean) the largest subgroup. Looking at the relative size of write-offs in relation to the total assets at the beginning of the period (untabulated) we see that the mean of the relative total write-offs amounts to 0.66% of total assets at the beginning of the period. Relative goodwill, other intangibles and property, plant and equipment write-offs amount to 0.29%, 0.15% and 0.22% respectively. In summary, write-offs of property, plant and equipment seem to occur more often, while write-offs of goodwill are higher in absolute and relative magnitude.

Concerning the performance variables, we see that the average return on assets amounts to 6.03 with a high standard deviation of 10.38. The mean operating cash flow is 10% of total assets at the beginning of the period. The mean values for the respective industry variables are the same as for the individuals. Additionally, we see that 21% of our sample firms had a market-to-book ratio below one and 74% had an industry average market-to-book ratio below the overall average of all sample firm-years. For our management incentive variables we see that the mean big bath indicator amounts to -0.02. As $BigBath_{it}$ equals the earnings management indicator, whenever this is below the industry mean earnings management indicator we expect a negative value for $BigBath_{it}$; the maximum value of 0.04 results from an industry mean earnings management indicator higher than that. The mean income smoothing indicator is 0.03, which as expected is a positive value. As there is no negative industry mean earnings management indicator the minimum value is zero. The mean debt-to-asset ratio is 24.84%.

For our control variables we see that the average change in gross domestic product amounts to 2%, with a minimum of -13% resulting from the United Kingdom in 2009 and a maximum of 20% resulting from Sweden in 2010. The mean natural logarithm of total assets amounts to 13.97, and the (untabulated) mean total assets amount to €6.6 billion. In 87% of our sample firm-years the audit has been conducted by a Big Four audit company. Similar to the results regarding the current period, in 43% of our sample firm-years a write-off in the previous firm-year has been recorded. 16% recorded a write-off of goodwill in the prior period, 15% a write-off of other intangibles and 31% a write-off of property, plant and equipment. The mean absolute amount of previous year total write-offs (untabulated) is €36 million, comprising mean absolute amounts of previous year write-offs of goodwill, other intangibles and property, plant and equipment of €18 million, €6 million and €13 million respectively. The relative amounts of write-offs are 0.59%, 0.24%, 0.13% and 0.23% of previous period total assets for total write-offs, write-offs of goodwill, write-offs of other intangibles and write-offs of property, plant and equipment respectively.

Table B.6 displays the descriptive statistics separated for companies that recorded a write-off and companies that did not record a write-off in the current period. In Panel A the segmentation is performed based on all companies, while panels B to D analyze the differences between write-off and non-write-off firm-years for the country clusters.

(Table B.6 about here)

Regarding Panel A we see that the return on assets and the relative operating cash flow are significantly higher for non-write-off firm-years than they are for write-off firm-years. Interestingly, the industry's mean of return on assets and relative operating cashflow are significantly higher for write-off firm-years than they are for non-write-off firm-years, indicating that write-off companies operate in industries with higher performance. 25% of the write-off firm-years have a market-to-book ratio below one, while this is true only for 17% of the non-write-off firm-years. Similarly, in 77% of the write-off firm-years and only 71% of the non-write-off firm-years the industry's mean market-to-book ratio is below the overall average market-to-book ratio of the whole sample. Both differences are statistically significant. Considering management incentives, we see that there is no significant difference in the big bath indicator while the income smoothing indicator is significantly higher for the non-write-off firm-years. This is in contrast to our expectations and may indicate that the companies that write off are not those with the highest performance. Similar results are presented by *Strong* and *Meyer* (1987). The debt-to-asset ratio of the write-off firm-years is significantly higher than that of the non-write-off firm-years, indicating that leverage is not an incentive for earnings management to reduce the cost of capital and the risk of a covenant breach but proxies for the monitoring by creditors. Our control variables are distributed as expected: write-off companies are significantly larger, have been audited significantly more often by a Big Four company and recorded a write-off in the previous year more often and of a lower magnitude than the non-write-off companies.

Regarding panels B to D of Table B.6, we see that most results are robust for the three country clusters but some are not. For 'outsider economies' and 'insider economies with weak enforcement' we see that neither the big bath indicator nor the income smoothing indicator is significantly different between the two groups, while for 'insider economies with strong enforcement' the means of both variables differ significantly. However, as with the income smoothing indicator in Panel A, the differences are the opposite of what we expected, indicating that in this cluster it is neither the best nor the worst performing company in a particular industry that records write-offs. Influences of the company's industry seem to be less important for 'insider economies'. We find that the industry's mean operating cash flow does not differ significantly between write-off and non-write-off companies in 'insider economies with strong enforcement'; this is also true for the indicator variable for an industry market-to-book ratio below the overall average for 'insider economies with weak enforcement'. For the latter, the company's individual operating cash flow, which should be the basis for the calculation of a write-off, is not significantly different either. In summary, we see that earnings management has no significant influence in outsider economies, but is significant for 'insider economies with strong enforcement'. For 'insider economies with weak enforcement' we do not find evidence of earnings management but see that it does not seem to be the operating cash flow that drives write-offs.

Table B.7 shows the correlation matrix of the variables used in the further analyses.

(Table B.7 about here)

The correlations are (after the preceding results) of the expected sign and relatively low. Hence multicollinearity should not be a problem for the further analyses.

3.5.2 Multivariate Results

3.5.2.1 Model Comparison and Overall Results

We start our analysis by comparing the Tobit model and the Cragg model. Table B.8 displays the results of the two regressions.

(Table B.8 about here)

A comparison of the results of the Tobit model to the results of the Cragg model is difficult, as in the former the participation decision and the amount decision are modeled at once, and we predicted different signs at the two stages for most variables. We see that the sign and significance of the performance variables are similar to those of the participation decision in the Cragg model, except for the industry's operating cash flow, which is significant at the 5% level with a negative sign in the Tobit model, similar to the amount decision in the Cragg model. The income smoothing indicator is significant (at 1%) with a negative sign, again comparable to the amount decision. The influence of the control variables is comparable to the participation decision except for the previous year write-off magnitude, which has a negative sign as in the amount decision of the Cragg model. The Tobit model has an adjusted R^2 (untabulated) of 9.51%, comparable to prior studies (*Francis*, *Hanna* and *Vincent* (1996); *Riedl* (2004); *AbuGhazaleh*, *Al-Hares* and *Roberts* (2011)). As it is nested in the Cragg model, we can easily test the models against each other using the likelihood ratio test. We obtain a likelihood-ratio statistic of 3,856, resulting in a p-value of essentially zero, and hence can strongly reject the Tobit model in favor of the Cragg model and conduct our further analysis applying the Cragg model alone.

Regarding hypothesis 1a we see that the influence of roa_{it} and mtb_{it} is significant at the 1% level and in line with our expectations. The probability of a write-off increases with a decreasing return on assets and when the market-to-book ratio falls below one. Contrary to our expectations, regarding the influence of ocf_{it} we find a significant (5%) positive influence on the write-off decision, meaning that companies with higher operating cash flows are more likely to recognize a write-off. *Cotter*, *Stokes* and *Wyatt* (1998) argue that companies with higher capacity to write down recognize higher write-offs because they are able to absorb financial effects such as increasing book value leverage without suffering a negative effect on their business. They use lower leverage and higher cash reserves as proxies for the capacity to write off. The increasing capacity to absorb write-offs due to higher operating cash flows could be an explanation for the positive relationship we find.

We find no support for our hypothesis 2a. ind_ocf_{it} and ind_mtb_{it} are not significant and ind_roa_{it} has a significant positive (5%) influence on the write-off probability. An increase in the write-off probability due to an increase in the average return on assets of the industry in which the company operates could – especially in combination with the significant negative influence of roa_{it} – result from higher pressure on individual firm performance in better performing industries. Looking at the results for roa_{it} and ind_roa_{it} in Table B.6 we see that for non-write-off firm-years the mean of roa_{it} is above that of ind_roa_{it}, while for write-off firm-years it is below the mean of ind_roa_{it}.

We do not find support for our hypotheses 3a and 4a either. All three variables, $BigBath_{it}$, $IncSmooth_{it}$ and dta_{it}, are insignificant for the write-off decision.

Looking at the control variables we find that Δgdp_{it} has no significant influence; $size_{it}$, $big4_{it}$ and wo_prev_{it} are significant at the 1% level and have the expected positive signs. WO_prev_{it} is significant as well (5%) but has a positive sign, contrary to our expectations, indicating that the probability of a write-off increases with higher previous year write-offs.

In the interpretation of the factors influencing the write-off magnitude several points require special attention. First, the results indicate the effect of the independent variables on the write-off magnitude, given that a write-off has been recognized. Second, we used the absolute value of the natural logarithm of write-off magnitude relative to the total assets at the beginning of the period as the dependent variable; therefore, in the interpretation of the signs we have to consider that a positive sign indicates a negative relationship between the dependent and independent variables.

Regarding hypothesis 1b we find roa_{it} to be significant at the 1% level with the expected positive sign, indicating that the write-off-magnitude – given that there is a write-off – increases with decreasing return on assets. ocf_{it} has a negative sign, indicating a positive influence as in the participation decision, but is significant only at the 10% level. Regarding hypothesis 2b, ind_roa_{it} has the expected positive sign (contrary to the influence on the write-off decision) and is significant at the 1% level, indicating that if a write-off is recognized, its magnitude increases with decreasing industry mean return on assets. This could follow from the reduced expectations for future development that follow from a reduced industry performance. Contrary to our expectations, ind_ocf_{it} is significant at the 1% level with a negative sign, indicating that a higher industry mean operating cash flow increases the write-off magnitude, conditional on a write-off being recognized. Similar to the argumentation for ocf_{it}, the positive influence could result from companies expecting lower future cash flows if they operate in industries with lower average operating cash flows and hence write off less, as they expect a decrease in their capacity to absorb write-offs.

We find strong support for our hypothesis 3b, as the big bath indicator is significant at the 5% level with the expected positive sign, indicating that if a write-off is recognized, its magnitude increases if the earnings of the company are unexpectedly low. The income smoothing indicator is significant at the 1% level with the expected negative sign, indicating that if a write-off is recorded its magnitude increases if the company's earnings are unexpectedly high. Again, we find no support for our hypothesis 4b as the influence of dta_{it} is not significant.

Regarding the control variables, we obtain the expected results except for WO_prev_{it}. If the company writes off, the write-off amount increases for smaller growth in gross domestic product and for smaller firm size. Whether the company has been audited by a Big Four audit company has no influence on the write-off magnitude. Contrary to our expectations, WO_prev_{it} has a negative sign and is significant at the 1% level. This indicates that if a write-off is recognized, the write-off magnitude increases with increasing magnitude of previous year write-offs.

Taken together, our results show that the write-off decisions of European publicly listed companies are mainly influenced by asset impairment while earnings management has no significant influence. On the other hand, earnings management is an important determinant of the write-off magnitude, conditional on the recognition of a write-off. While asset impairment has a significant influence as well, we find highly significant evidence of income smoothing and big bath accounting.

3.5.2.2 Results by Country Cluster

The results of our analysis by country cluster are given in Table B.9. The results of the Cragg model for all countries from Table B.8 are given as a reference.

(Table B.9 about here)

For 'outsider economies' we see that the write-off decision seems to be driven only by asset impairment. roa_{it} and mtb_{it} have a significant influence on the expected direction while industry influences are not significant. Hence we can confirm hypothesis 1a but cannot confirm hypothesis 2a. There is no significant evidence of earnings management either; $BigBath_{it}$, $IncSmooth_{it}$ and dta_{it} are not significant.

For the write-off magnitude this looks quite different. While there is still a significant negative influence of roa_{it}, industry influences are significant here as well. ind_roa_{it} has a significant negative influence, in line with hypothesis 2b, but ind_ocf_{it} is significant with a positive influence. We additionally find evidence for hypothesis 3b, as $BigBath_{it}$ and $IncSmooth_{it}$ are significant with the expected signs.

For 'insider economies with strong enforcement' we find a significant influence of asset impairment on the write-off decision too, as roa_{it} and mtb_{it} are significant with the expected signs. However, we also find that ocf_{it} and ind_roa_{it} have a significant positive influence, contrary to what we expected. Additionally, $IncSmooth_{it}$ has a significant negative influence, indicating that companies with an unexpectedly high income do not take write-offs. dta_{it} is significantly negative, supporting the hypothesis that highly levered firms try to delay write-offs.

For the write-off magnitude we find support for our hypotheses 1b and 2b as roa_{it}, and ind_roa_{it} have a significant negative influence. ind_ocf_{it} is significant with a positive influence, contrary to our expectations. We do not find evidence for hypotheses 3b or 4b here.

In 'insider economies with weak enforcement' the write-off decision seems to be driven by firm performance. However, while roa_{it} and mtb_{it} are significant with the expected signs, we again find a significant positive influence of ocf_{it}.

The write-off magnitude seems to be determined materially by firm performance, and roa_{it} has a highly significant negative influence. However, here we find weak evidence of income smoothing, as $IncSmooth_{it}$ has a significant negative influence.

Table B.10 gives an overview of the confirmation and rejection of our hypotheses for the regressions by country cluster.

(Table B.10 about here)

Taken together, we could not confirm our assumption that the influence of asset impairment decreases from cluster 1 to cluster 3 while that of earnings management increases. Rather, we find evidence of earnings management in all three clusters, but it is clear that different strategies are applied. In 'outsider economies' we find strong evidence of big bath accounting and income smoothing in the write-off magnitude. The motivation for both strategies is to influence the perception of capital market participants, which is most important for countries in 'outsider economies'. So, contrary to what we expected, the high investor protection in 'outsider economies' does not suffice to prevent earnings management from influencing the write-off magnitude. For the 'insider economies' we did not find such clear patterns of earnings management, but one characteristic of such economies is that the capital market is not that important. Hence, it is not too surprising that we do not find strong evidence of big bath accounting and income smoothing. Nevertheless, the significant positive influence of the operating cash flow still indicates that write-offs are managed. Finally, this analysis proves that the factors that drive fixed asset write-offs vary between the EU15 member states and that further steps are necessary to reach uniform accounting across Europe.

3.5.2.3 Changes in Differences between Country Clusters

It could be assumed that differences in the process to determine write-offs reduce over time. On the contrary, *Kvaal* and *Nobes* (2012) argue that a company has an incentive to maintain its accounting policy over time to reduce costs. To analyze whether the differences in the processes driving write-offs decrease we partition our sample into two periods, the first ranging from 2005 to 2008 and the second from 2009 to 2011. For each country cluster we then compute the regression for both periods to see whether there are material changes in the determinants of fixed asset write-offs and whether – due to these changes – the practices are more similar in the latter period or if national differences persist. Table B.11 shows the results of the regressions for the two periods.

(Table B.11 about here)

Regarding the write-off decision, we see that firm performance is less important in the second period. For 'outsider economies' roa_{it} is completely insignificant, and for the ‘insider economies’ the positive influence of ocf_{it} becomes insignificant. While the influence of mtb_{it} becomes insignificant for clusters 1 and 2, it is significant only in the second period for cluster 3. Similarly, ind_roa_{it} is significant in the second period for clusters 1 and 2 but only in the first period for cluster 3.

Regarding the write-off magnitude we see again that the association with firm performance decreases; roa_{it} is completely insignificant for ‘outsider economies’ and ocf_{it} becomes insignificant in cluster 3. In contrast, the association with ind_roa_{it} increases for clusters 1 and 2 and ind_ocf_{it} becomes significant for cluster 1. Interestingly, we see that $IncSmooth_{it}$ has a significant negative influence in the first period for all three clusters but becomes insignificant in the second period. However, for cluster 2 $BigBath_{it}$ becomes significant in the second period.

In summary, we see that there are certain changes in the processes that drive write-offs. Two important points have to be noted for these changes. First, changes seem to reduce the influence of asset impairment on write-offs. Second, while the processes that drive write-offs in clusters 1 and 2 seem to become more similar, the determinants of write-offs in cluster 3 change somewhat individually.

3.6 Further Analyses

3.6.1 Results by Industry

To see whether systematic differences in the write-off behavior between different industries exist, we ran our regression separately for all industries. The results of these analyses are given in Table B.12. Mirroring our approach in the country cluster analysis, we included the results of the Cragg model for all industries as a reference.

(Table B.12 about here)

From Table B.12 we see that the determinants of fixed asset write-offs vary significantly over the industries analyzed. We sorted the industries according to the write-off behavior; industries in which write-offs largely depend on asset impairment are displayed on the left side, while industries in which earnings management is an important factor are displayed on the right. We did not obtain plausible results for the determinants of write-offs in the mining industry. Hence, either write-offs in the 'Mining'-industry are determined by factors we did not include in our analysis, or the insignificant results follow from the relatively small sample size. Similarly, the results for the industries 'Wholesale Trade' and 'Construction' have to be interpreted cautiously as we do not find significant results, at least for the write-off decision.

For the first stage regarding hypothesis 1a we see that roa_{it} has a significant negative influence and ocf_{it} has a significant positive influence for the industries 'Service', 'Manufacturing', 'Transportation, Communications, Electric, Gas, and Sanitary Services' (henceforth 'Transportation' for simplicity), and 'Retail Trade', as in the analysis of all industries. mtb_{it} has no significant influence in the 'Transportation' industry but is significantly positive for the other three industries and 'Wholesale Trade'. Hence, we obtain results that support hypothesis 1a as well as results that negate it for all industries except for 'Construction' and 'Mining', for which we obtain no significant results. $IncSmooth_{it}$ and $BigBath_{it}$ are insignificant for all industries except 'Wholesale Trade', where $IncSmooth_{it}$ has a significant (10%) negative influence, suggesting that the best companies in this industry do not write off. dta_{it} has a significant negative influence in the 'Transportation' industry, confirming hypothesis 4a, and is insignificant for all other industries. $size_{it}$ is significantly positive for all industries except 'Construction' and 'Mining', and wo_prev_{it} is significantly positive for all industries. Surprisingly, $big4_{it}$ is significant only in the 'Manufacturing' industry, which is by far the largest industry and hence probably drives the results of our main regression.

Similarly, WO_prev_{it} has a significant negative influence only for 'Manufacturing' and 'Transportation' companies.

The results for the amount decision are a little more surprising. roa_{it} has a significant negative influence in support of hypothesis 1a, as in the main regression, for all industries except 'Mining'. Contrary to hypothesis 1a, ocf_{it} is significant with a negative sign for the industries 'Services', 'Retail Trade', and 'Wholesale Trade', which , with the addition of 'Construction', are the industries in which $BigBath_{it}$ is significant. This is another indicator that the positive relationship between ocf_{it} and WO_{it} results from earnings management. $IncSmooth_{it}$ is significant with a negative sign in line with our expectations in all industries except 'Services' and 'Mining'. As in the main regression, WO_prev_{it}has a significant influence for all industries except 'Mining'. The results are presented in a condensed form in Table B.13.

(Table B.13 about here)

Summarizing the above discussion we see that the determinants of fixed asset write-offs and the use of earnings management vary across the industries. While the participation decision follows similar processes across the industries, except for 'Wholesale Trade,' 'Construction' and 'Mining', which have small sample sizes, the amount decision follows different patterns. Big bath accounting is significant only for 'Services', 'Retail Trade', 'Wholesale Trade' and 'Construction'; income smoothing, on the other hand, prevails in all industries except 'Services' and 'Mining'.

3.6.2 Results by Type of Write-off

Francis, *Hanna* and *Vincent* (1996) state that they expect earnings management to be more important in determining write-offs of goodwill than of property, plant and equipment. They explain their assumption as the result of the existence of market prices for the latter group and the necessity of subjective valuation for the former. To analyze whether different determinants drive fixed asset write-offs we analyze the write-offs of goodwill, other intangible assets and property, plant and equipment separately. Similar to *Francis*, *Hanna* and *Vincent* (1996) we assume that write-offs of goodwill are driven by earnings management, while write-offs of property, plant and equipment are driven by asset impairment. Other intangible assets are assumed to be somewhere in the middle as this category comprises assets for which market prices exist as well as assets without market prices. Table B.14 shows the results of the regressions with the basic regression from Table B.8 as a reference, as before.

(Table B.14 about here)

Looking at the participation decision we see for hypothesis 1a that the influence of roa_{it} is in line with our expectations; it is robust for all types of write-offs and equal to that in the regression for all write-offs. The negative influence of ocf_{it}, which is contrary to our hypothesis 1a, is significant only for goodwill write-offs (1%) and other intangible asset write-offs (10%), another indication that this is due to earnings management, as assumed. In contrast, the positive influence of mtb_{it} is significant for goodwill and property, plant and equipment write-offs but insignificant for write-offs of other intangible assets. Regarding hypothesis 2a we find that the positive influence of ind_roa_{it} on the write-off decision seems to be driven solely by write-offs of property, plant and equipment. Interestingly, we find a significant negative influence of ind_ocf_{it} for property, plant and equipment, supporting hypothesis 2a, while there is a highly significant positive relationship with other intangible asset write-offs, contrary to hypothesis 2a. This is again suggestive of earnings management. For ind_mtb_{it} we find a positive influence for other intangible assets and property, plant and equipment, which is in line with our expectations; surprisingly, we find a significant negative relation for write-offs of goodwill, indicating that the write-off probability decreases if the market-to-book ratio of the industry is relatively low. This result could stem from the fact that managers try to delay goodwill write-offs when their expectations are bad.

Consistent with our expectations we find a significant relationship of $BigBath_{it}$ and $IncSmooth_{it}$ with the probability of goodwill write-offs, but the signs are the opposite of what we expected; hence, we have to reject hypothesis 3a for goodwill. This result is again comparable to the finding of *Strong* and *Meyer* (1987). Neither the strongest nor the weakest companies in a particular industry recognize goodwill write-offs. On the contrary, we find support for big bath accounting for other intangible assets. There is no significant relationship of $BigBath_{it}$ and $IncSmooth_{it}$ with the probability of write-offs of property, plant and equipment. dta_{it} has a significant negative influence on the goodwill write-off probability, which shows that the write-off probability decreases with rising leverage. Additionally, we find that $big4_{it}$ is insignificant for goodwill write-offs, while it is highly significant for write-offs of other intangible assets and property, plant and equipment. The influence of $size_{it}$ and wo_prev_{it} is in line with our expectations and robust for all types of write-offs.

Regarding the second stage we see again that the influence of roa_{it} is robust over all types of write-offs, confirming hypothesis 1b. ocf_{it} is highly significant with a negative sign for write-offs of property, plant and equipment, which is contrary to what we expected, and insignificant for the other types of write-off, while ind_ocf_{it} is significant with a negative sign only for these types. The other results are in sharp contrast to what we expected: ind_roa_{it} is highly significant with a positive sign as expected only for write-offs of goodwill and other intangible assets. $BigBath_{it}$ and $IncSmooth_{it}$ are highly significant with the expected signs for write-offs of property, plant and equipment. $IncSmooth_{it}$ is significant for other intangible assets as well, but both earnings management variables are insignificant for write-offs of goodwill.

Thus, contrary to what we expected we can confirm hypothesis 3b for other intangible assets and property, plant and equipment but not for goodwill. dta_{it} is insignificant for all types of write-offs. As in the first stage, $size_{it}$ and WO_prev_{it} have a significant influence that is in line with the overall regression. Table B.15 provides an overview of the rejection and confirmation of our hypotheses.

(Table B.15 about here)

Altogether we find mixed results. We could not confirm our assumption that write-offs of property, plant and equipment follow asset impairment while goodwill write-offs are driven by earnings management. Rather, all analyzed types of write-offs seem to be driven by asset impairment and earnings management. For the write-off decision we find more support for earnings management for write-offs of goodwill, but there is strong support for income smoothing and big bath accounting regarding the write-off magnitude for property, plant and equipment. The participation decision as well as the amount decision for write-offs of other intangible assets is significantly driven by earnings management.

3.7 Robustness and Limitations

To be sure about our model choice we performed the analyses for country clusters, industries and types of write-offs for both the Cragg model and the Tobit model. For all regressions we had to reject the Tobit model in favor of the Cragg model, implying that our model choice seems to be correct. That said, the Tobit model still reached pseudo R^2 between 9% and 14%, which is comparable to prior studies.

Regarding our management incentives for income smoothing and big bath accounting we assumed a geometric Brownian motion to drive the EBIT with the industry's mean EBIT growth as drift. *Francis*, *Hanna* and *Vincent* (1996) assume a random walk and hence no drift to drive the pre-write-off earnings. We repeated our basic regression with our income smoothing and big bath indicator defined based on a random walk – the big bath indicator equals the earnings management indicator when this is below zero and the income smoothing indicator equals the earnings management indicator when it is above zero – and obtained qualitatively similar results, although the significance of the management incentives decreased. Similarly, we repeated our analysis to define the management incentives in accordance with *Riedl* (2004) and *AbuGhazaleh*, *Al-Hares* and *Roberts* (2011). The income smoothing indicator equals the earnings management indicator when this is above the median of non-zero positive values within the industry, and the big bath indicator equals the earnings management indicator when this is below the median of non-zero negative values within the industry. Neither *Riedl* (2004) nor *AbuGhazaleh*, *Al-Hares* and *Roberts* (2011) include the industry in this analysis, but we think that this is straightforward as we include industries in this analysis. Using this definition we obtain similar results as for the definition following *Francis*, *Hanna* and *Vincent* (1996).

Across all our analyses we find a positive influence of the operating cash flow and the industry's mean operating cash flow on the write-off decision and magnitude. This result could proxy for earnings management, but could also result from the fact that we had to use data at the company level to proxy for impairment at the asset level. This is a limitation due to data availability that could not be avoided.

Furthermore, we did not include measures for management changes, earnings-based bonus payments or corporate governance in our analyses, which have previously been shown to have a significant influence on fixed asset write-offs. The goal of our analysis was to gain an overview of the processes that drive fixed asset write-offs across Europe. Therefore, we focused on national differences. Further analyses, including differences at the company level, will have to be conducted to gain a complete understanding of all determinants.

3.8 Conclusion

This study analyzes the determinants of fixed asset write-offs in Europe. We compare the Cragg model and the Tobit model and find that the Cragg model fits better. This model has the advantage that the drivers of the participation decision (whether the company recognizes a write-off) can by analyzed separately from the drivers of the amount decision (given that the company recognizes a write-off, what amount will be written off). We find that the participation decision is mainly driven by asset impairment while there is strong support for big bath accounting and income smoothing in the amount decision. Analyzing the three country clusters ‘outsider economies’, ‘insider economies with strong enforcement’ and ‘insider economies with weak enforcement’, we find that in ‘outsider economies’ the write-off magnitude seems to be driven by earnings management. For the two clusters for ‘insider economies’ we do not obtain such clear results, but we can show that it is not only asset impairment that drives write-offs. Altogether, we find that there are large differences in the drivers of write-off decisions and magnitudes across the country clusters that did not dissolve over time.

This analysis shows that the harmonization of financial reporting, which was the aim of the mandatory adoption of IFRS, has not yet happened. As the processes that drive asset write-offs in ‘outsider economies’ and ‘insider economies with strong enforcement’ seem to align, we have to conclude that enforcement is important in reaching this harmonization. In conclusion we have to agree with the existing literature which assumes that uniform financial reporting requires a uniform European enforcement mechanism.

Appendix B

Table B.1: Sample selection

Panel A: Selection of the final sample for further analysis

	companies	firm-years
Companies listed in the Datastream Global Equity Indices of EU15 member states between 2004 and 2011	1,893	15,144
Not EU15	(23)	(184)
Financial companies	(490)	(3,920)
No complete dataset	(78)	(3,765)
Industry with fewer than five companies	(2)	(7)
Final sample of firm-years	1,300	7,268

Panel B: Sample by country

	companies	firm-years
Austria	33	204
Belgium	61	365
Denmark	33	183
Finland	42	253
France	188	1,063
Germany	181	1,062
Greece	39	230
Ireland	33	169
Italy	109	598
Luxembourg	9	52
Netherlands	83	460
Portugal	41	230
Spain	95	531
Sweden	48	283
United Kingdom	305	1,585
Total	1,300	7,268

Panel C: Sample by industry

	companies	firm-years
Agriculture, Forestry and Fishing	13	75
Mining	64	333
Construction	81	452
Manufacturing	612	3,499
Transportation, Communications, Electric, Gas and Sanitary Services	179	1,009
Wholesale Trade	51	283
Retail Trade	78	406
Services	222	1,211
Total	1,300	7,268

Panel D: Sample by type of write-off

	companies	firm-years
Companies reporting write-offs	957	3,269
Companies reporting goodwill write-offs	558	1,183
Companies reporting write-offs of intangible assets (other than goodwill)	510	1,246
Companies reporting write-offs of property, plant and equipment	751	2,383

Table B.1 describes the sample used for the further analysis. Panel A exhibits the process of sample selection and panels B to D partition the sample by country, industry and type of write-off.

Table B.2: Allocation of countries to country clusters

Cluster 1: Outsider economies	**Cluster 2: Insider economies with high enforcement**	**Cluster 3: Insider economies with low enforcement**
United Kingdom	Austria	Greece
	Germany	Portugal
	Belgium	Italy
	Netherlands	Spain
	Denmark	
	France	
	Finland	
	Sweden	
	Ireland	

Table B.2 displays the allocation of the sample countries to the three country clusters according to *Leuz*, *Nanda* and *Wysocki* (2003).

Table B.3: Variable definitions

wo_{it}	An indicator variable equal to 1 if company i recognized a write-off in t and zero otherwise.
$(.)\_wo_{it}$	An indicator variable equal to 1 if company i recognized a write-off of (.) – GW for Goodwill, Int for other intangible assets or PPE for property plant and equipment – in t and zero otherwise.
WO_{it}	The natural logarithm of the fixed asset write-offs of company i in t relative to the total assets of company i in the period previous to t when company i recognized a write-off in t and zero otherwise.
$(.)\_WO_{it}$	The natural logarithm of the fixed asset write-offs of company i on (.) – GW for Goodwill, Int for other intangible assets or PPE for property plant and equipment – in t relative to the total assets of company i in the period previous to t when company i recognized a write-off in t and zero otherwise.
roa_{it}	The return on assets of company i in t.
ocf_{it}	The operating cash flow from company i in t divided by total assets of company i at the end of the period previous to t.
mtb_{it}	An indicator variable equal to 1 if the market-to-book ratio of company i is lower than 1 in t and zero otherwise.
ind_roa_{it}	The mean return on assets of company i's industry in t; industries are defined based on the SIC code divisions.
ind_ocf_{it}	The mean operating cash flow scaled by previous period total assets from company i's industry in t; industries are defined based on the SIC code divisions.
ind_mtb_{it}	An indicator variable equal to 1 if the mean market-to-book ratio of company i's industry is lower than the mean market-to-book ratio of all sample companies in t and zero otherwise.
emi_{it}	The difference between EBIT before impairment losses of company i in t and previous year EBIT of company i scaled by previous year total assets.
$BigBath_{it}$	Proxy for unexpected low earnings equal to emi_{it} if emi_{it} is lower than the mean of emi_{it} over i's industry and zero otherwise.
$IncSmooth_{it}$	Proxy for unexpected high earnings equal to emi_{it} if emi_{it} exceeds the mean of emi_{it} over i's industry and zero otherwise.
dta_{it}	The debt-to-asset ratio of company i in t.
Δgdp_{it}	The change in gross domestic product of the country company i is domiciled in from $t-1$ to t.
$size_{it}$	The natural logarithm of total assets of company i in t.
$big4_{it}$	An indicator variable equal to 1 if company has been audited by a Big Four audit company – KPMG, PwC, Deloitte, Ernst & Young – in t and zero otherwise.
wo_prev_{it}	An indicator variable equal to 1 if company i recognized a write-off in the period previous to t and zero otherwise.
$(.)\_wo\_prev_{it}$	An indicator variable equal to 1 if company i recognized a write-off of (.) – GW for Goodwill, Int for other intangible assets or PPE for property plant and equipment – in the period previous to t and zero otherwise.
WO_prev_{it}	The natural logarithm of the fixed asset write-offs of company i in the period previous to t relative to the total assets of company i in the period previous to t when company i recognized a write-off in this period and zero otherwise.
$(.)\_WO\_prev_{it}$	The natural logarithm of the fixed asset write-offs of company i on (.) – GW for Goodwill, Int for other intangible assets or PPE for property plant and equipment – in the period previous to t relative to the total assets of company i in the period previous to t when company i recognized a write-off in this period and zero otherwise.

Table B.3 exhibits the variable definitions for the variables used in the further analyses.

Table B.4: Rationale for expected signs

Write-off decision			*Write-off magnitude*			
Change in independent variable	Expected change in write-off probability	Resulting expected sign	Expected change in relative write-off magnitude	Resulting change in the natural logarithm of the relative write-off magnitude	Resulting change in the absolute value	Resulting expected sign
roa_{it} $\uparrow$	$Pr(wo_{it}=1)$ $\downarrow$	-	$EXP(WO_{it})$ $\downarrow$	WO_{it} $\downarrow$	$\lvert WO_{it}\rvert$ $\uparrow$	+
ocf_{it} $\uparrow$	$Pr(wo_{it}=1)$ $\downarrow$	-	$EXP(WO_{it})$ $\downarrow$	WO_{it} $\downarrow$	$\lvert WO_{it}\rvert$ $\uparrow$	+
mtb_{it} $\uparrow$	$Pr(wo_{it}=1)$ $\uparrow$	+	n.a.	n.a.	n.a.	n.a.
ind_roa_{it} $\uparrow$	$Pr(wo_{it}=1)$ $\downarrow$	-	$EXP(WO_{it})$ $\downarrow$	WO_{it} $\downarrow$	$\lvert WO_{it}\rvert$ $\uparrow$	+
ind_ocf_{it} $\uparrow$	$Pr(wo_{it}=1)$ $\downarrow$	-	$EXP(WO_{it})$ $\downarrow$	WO_{it} $\downarrow$	$\lvert WO_{it}\rvert$ $\uparrow$	+
ind_mtb_{it} $\uparrow$	$Pr(wo_{it}=1)$ $\uparrow$	+	n.a.	n.a.	n.a.	n.a.
$BigBath_{it}$ $\uparrow$	$Pr(wo_{it}=1)$ $\downarrow$	-	$EXP(WO_{it})$ $\downarrow$	WO_{it} $\downarrow$	$\lvert WO_{it}\rvert$ $\uparrow$	+
$IncSmooth_{it}$ $\uparrow$	$Pr(wo_{it}=1)$ $\uparrow$	+	$EXP(WO_{it})$ $\uparrow$	WO_{it} $\uparrow$	$\lvert WO_{it}\rvert$ $\downarrow$	-
dta_{it} $\uparrow$	$Pr(wo_{it}=1)$ n.a.	+/-	$EXP(WO_{it})$ n.a.	WO_{it} n.a.	$\lvert WO_{it}\rvert$ n.a.	+/-
Δgdp_{it} $\uparrow$	$Pr(wo_{it}=1)$ $\downarrow$	-	$EXP(WO_{it})$ $\downarrow$	WO_{it} $\downarrow$	$\lvert WO_{it}\rvert$ $\uparrow$	+
$size_{it}$ $\uparrow$	$Pr(wo_{it}=1)$ $\uparrow$	+	$EXP(WO_{it})$ $\downarrow$	WO_{it} $\downarrow$	$\lvert WO_{it}\rvert$ $\uparrow$	+
$big4_{it}$ $\uparrow$	$Pr(wo_{it}=1)$ $\uparrow$	+	$EXP(WO_{it})$ $\downarrow$	WO_{it} $\downarrow$	$\lvert WO_{it}\rvert$ $\uparrow$	+
wo_prev_{it} $\uparrow$	$Pr(wo_{it}=1)$ $\uparrow$	+	n.a.	n.a.	n.a.	n.a.
WO_prev_{it} $\uparrow$	$Pr(wo_{it}=1)$ $\downarrow$	-	$EXP(WO_{it})$ $\downarrow$	WO_{it} $\downarrow$	$\lvert WO_{it}\rvert$ $\uparrow$	+

Table B.4 gives a rationale for the expected signs in the regression analysis. The expression $EXP(WO_{it})$ indicates that we raise the natural logarithm of the relative write-offs to the power of the Euler constant to receive the relative write-off.

Table B.5: Descriptive statistics

continuous variables	*Mean*	*Standard Deviation*	*Min*	*25%-Quartile*	*Median*	*75%-Quartile*	*Max*	*N*
WO_{it}	-2.61	3.15	-14.47	-5.46	0.00	0.00	0.37	7,268
GW_WO_{it}	-0.95	2.32	-13.89	0.00	0.00	0.00	0.37	7,268
Int_WO_{it}	-1.14	2.64	-15.49	0.00	0.00	0.00	0.00	7,268
PPE_WO_{it}	-2.09	3.17	-14.47	-5.15	0.00	0.00	0.00	7,268
roa_{it}	6.03	10.38	-174.60	2.95	5.79	9.32	134.10	7,268
ocf_{it}	0.10	0.13	-3.18	0.05	0.09	0.14	2.62	7,268
ind_roa_{it}	6.03	0.89	4.14	5.42	6.18	6.18	8.09	7,268
ind_ocf_{it}	0.10	0.02	0.06	0.10	0.10	0.10	0.15	7,268
$BigBath_{it}$	-0.02	0.06	-3.88	-0.01	0.00	0.00	0.04	7,268
$IncSmooth_{it}$	0.03	0.07	0.00	0.00	0.00	0.04	1.84	7,268
dta_{it}	24.84	21.24	0.00	10.88	23.30	35.32	885.58	7,268
Δgdp_{it}	0.02	0.06	-0.13	0.00	0.03	0.05	0.20	7,268
$size_{it}$	13.97	1.81	3.91	12.71	13.86	15.09	19.39	7,268
WO_prev_{it}	-2.52	3.17	-14.53	-5.45	0.00	0.00	0.00	7,268
$GW\_WO\_prev_{it}$	-0.94	2.33	-13.75	0.00	0.00	0.00	0.00	7,268
$Int\_WO\_prev_{it}$	-1.02	2.55	-15.75	0.00	0.00	0.00	0.00	7,268
$PPE\_WO\_prev_{it}$	-2.00	3.14	-14.53	-4.94	0.00	0.00	0.00	7,268

Indicator variables	*Mean*	*Standard Deviation*		*0*	*1*			*N*
wo_{it}	0.45	0.50		3,999	3,269			7,268
GW_wo_{it}	0.16	0.37		6,085	1,183			7,268
Int_wo_{it}	0.17	0.38		6,022	1,246			7,268
PPE_wo_{it}	0.33	0.47		4,885	2,383			7,268
mtb_{it}	0.21	0.41		5,765	1,503			7,268
ind_mtb_{it}	0.74	0.44		1,900	5,368			7,268
$big4_{it}$	0.87	0.34		948	6,320			7,268
wo_prev_{it}	0.43	0.49		4,160	3,108			7,268
$GW\_wo\_prev_{it}$	0.16	0.36		6,135	1,133			7,268
$Int\_wo\_prev_{it}$	0.15	0.36		6,165	1,103			7,268
$PPE\_wo\_prev_{it}$	0.31	0.46		4,996	2,272			7,268

Table B.5 provides descriptive statistics for the sample observations.

Table B.6: Descriptive statistics separated by write-off and non-write-off firm-years

	Panel A: All companies						*Panel B: Outsider Economies*					
	Non-write-off firm-years (N=3,999)			Write-off firm-years (N=3,269)			Non-write-off firm-years (N=980)			Write-off firm-years (N=605)		
	Mean (p-value)	Median	Standard Deviation	Mean	Median	Standard Deviation	Mean (p-value)	Median	Standard Deviation	Mean	Median	Standard Deviation
roa_{it}	7.32	6.58	10.41	4.45	4.76	10.13	9.59	7.98	8.94	6.50	5.86	11.94
	(0.000)						(0.000)					
ocf_{it}	0.11	0.10	0.15	0.09	0.08	0.11	0.14	0.12	0.11	0.12	0.10	0.10
	(0.000)						(0.003)					
mtb_{it}	0.17	0.00	0.38	0.25	0.00	0.43	0.13	0.00	0.34	0.23	0.00	0.42
	(0.000)						(0.000)					
ind_roa_{it}	5.98	6.18	0.88	6.09	6.18	0.91	6.11	6.18	1.05	6.45	6.18	1.17
	(0.000)						(0.000)					
ind_ocf_{it}	0.102	0.10	0.02	0.103	0.10	0.02	0.105	0.10	0.02	0.110	0.10	0.02
	(0.006)						(0.000)					
ind_mtb_{it}	0.71	1.00	0.45	0.77	1.00	0.42	0.60	1.00	0.49	0.66	1.00	0.47
	(0.000)						(0.032)					
$BigBath_{it}$	-0.02	0.00	0.08	-0.01	0.00	0.04	-0.01	0.00	0.04	-0.02	0.00	0.04
	(0.380)						(0.201)					
$IncSmooth_{it}$	0.033	0.00	0.08	0.028	0.00	0.06	0.03	0.00	0.07	0.03	0.00	0.07
	(0.007)						(0.442)					
dta_{it}	23.55	21.27	24.38	26.41	25.53	16.46	19.95	18.06	17.50	24.12	22.84	15.47
	(0.000)						(0.000)					
Δgdp_{it}	0.02	0.03	0.06	0.01	0.03	0.06	-0.01	0.02	0.09	-0.02	0.02	0.09
	(0.002)						(0.003)					
$size_{it}$	13.43	13.38	1.64	14.63	14.52	1.80	13.59	13.40	1.40	14.63	14.49	1.72
	(0.000)						(0.000)					
$big4_{it}$	0.83	1.00	0.37	0.91	1.00	0.28	0.94	1.00	0.25	0.98	1.00	0.13
	(0.000)						(0.000)					
wo_prev_{it}	0.19	0.00	0.40	0.71	1.00	0.45	0.19	0.00	0.39	0.66	1.00	0.48
	(0.000)						(0.000)					
WO_prev_{it}	-1.16	0.00	2.54	-4.19	-4.95	3.06	-0.95	0.00	2.16	-3.46	-4.14	2.84
	(0.000)						(0.000)					

	Panel C: Insider economies with strong enforcement						Panel D: Insider economies with weak enforcement					
	Non-write-off firm-years (N=2,073)			Write-off firm-years (N=1,969)			Non-write-off firm-years (N=910)			Write-off firm-years (N=679)		
	Mean (p-value)	Median	Standard Deviation	Mean	Median	Standard Deviation	Mean (p-value)	Median	Standard Deviation	Mean	Median	Standard Deviation
roa_{it}	7.17	6.75	11.46	4.39	4.94	10.06	5.13	4.69	8.89	2.74	3.61	8.14
	(0.000)						(0.000)					
ocf_{it}	0.11	0.10	0.17	0.09	0.09	0.12	0.08	0.07	0.13	0.07	0.07	0.08
	(0.000)						(0.215)					
mtb_{it}	0.15	0.00	0.36	0.21	0.00	0.41	0.26	0.00	0.44	0.37	0.00	0.48
	(0.000)						(0.000)					
ind_roa_{it}	6.01	6.18	0.78	6.06	6.18	0.82	5.78	6.18	0.86	5.87	6.18	0.81
	(0.054)						(0.025)					
ind_ocf_{it}	0.103	0.10	0.01	0.102	0.10	0.01	0.098	0.10	0.02	0.099	0.10	0.01
	(0.351)						(0.070)					
ind_mtb_{it}	0.72	1.00	0.45	0.79	1.00	0.41	0.80	1.00	0.40	0.81	1.00	0.39
	(0.000)						(0.510)					
$BigBath_{it}$	-0.02	0.00	0.06	-0.01	0.00	0.04	-0.02	0.00	0.13	-0.02	0.00	0.04
	(0.097)						(0.695)					
$IncSmooth_{it}$	0.037	0.00	0.10	0.028	0.00	0.06	0.022	0.00	0.07	0.022	0.00	0.06
	(0.000)						(0.930)					
dta_{it}	21.98	19.05	28.14	24.56	23.83	15.83	31.44	30.81	19.54	34.11	33.92	16.92
	(0.000)						(0.004)					
Δgdp_{it}	0.029	0.04	0.04	0.025	0.03	0.04	0.02	0.02	0.04	0.01	0.02	0.03
	(0.020)						(0.000)					
$size_{it}$	13.30	13.34	1.72	14.71	14.63	1.83	13.54	13.39	1.66	14.33	14.23	1.73
	(0.000)						(0.000)					
$big4_{it}$	0.81	1.00	0.40	0.90	1.00	0.30	0.80	1.00	0.40	0.90	1.00	0.30
	(0.000)						(0.000)					
wo_prev_{it}	0.21	0.00	0.41	0.74	1.00	0.44	0.16	0.00	0.37	0.70	1.00	0.46
	(0.000)						(0.000)					
WO_prev_{it}	-1.30	0.00	2.67	-4.33	-5.11	2.98	-1.08	0.00	2.60	-4.46	-5.15	3.37
	(0.000)						(0.000)					

Table B.6 depicts descriptive statistics separated by write-off firm-years and non-write-off firm-years. Significance levels of t-tests for differences in means are reported in parentheses. Panel A presents the results for all companies and panels B to D present the results for the country clusters.

Table B.7: Correlation analysis

	wo_{it}	WO_{it}	roa_{it}	ocf_{it}	mtb_{it}	ind_roa_{it}	ind_ocf_{it}	ind_mtb_{it}	$BigBath_{it}$	$IncSmooth_{it}$	dta_{it}	Δgdp_{it}	$size_{it}$	$big4_{it}$	wo_prev_{it}	WO_prev_{it}
wo_{it}	1.000	-0.943	-0.194	-0.104	0.088	0.055	-0.011	0.063	-0.025	-0.023	0.118	-0.077	0.329	0.118	0.522	-0.492
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.346)	(0.000)	(0.035)	(0.048)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
WO_{it}	-0.916	1.000	-0.219	-0.110	0.096	0.052	-0.018	0.082	-0.037	-0.034	0.134	-0.080	0.436	0.135	0.523	0.500
	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.117)	(0.000)	(0.002)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
roa_{it}	-0.138	-0.153	1.000	0.610	-0.342	0.109	0.081	-0.028	0.233	0.293	-0.245	0.217	-0.057	0.006	-0.119	0.096
	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.016)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.637)	(0.000)	(0.000)
ocf_{it}	-0.067	-0.067	0.732	1.000	-0.329	0.110	0.136	-0.037	0.186	0.270	-0.227	0.172	-0.061	0.002	-0.080	0.071
	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.836)	(0.000)	(0.000)
mtb_{it}	0.088	0.095	-0.195	-0.180	1.000	-0.020	-0.066	0.031	-0.145	-0.129	0.137	-0.210	0.023	-0.047	0.042	-0.033
	(0.000)	(0.000)	(0.000)	(0.000)		(0.094)	(0.000)	(0.009)	(0.000)	(0.000)	(0.000)	(0.000)	(0.047)	(0.000)	(0.000)	(0.005)
ind_roa_{it}	0.062	0.067	0.086	0.099	-0.033	1.000	0.479	-0.019	0.011	0.022	-0.099	0.006	-0.050	-0.017	0.059	-0.044
	(0.000)	(0.000)	(0.000)	(0.000)	(0.005)		(0.000)	(0.111)	(0.370)	(0.056)	(0.000)	(0.616)	(0.000)	(0.138)	(0.000)	(0.000)
ind_ocf_{it}	0.032	0.044	0.073	0.118	-0.058	0.844	1.000	-0.171	0.042	0.012	-0.144	-0.004	-0.184	-0.051	-0.006	0.030
	(0.006)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.328)	(0.000)	(0.709)	(0.000)	(0.000)	(0.612)	(0.011)
ind_mtb_{it}	0.063	0.084	-0.007	-0.020	0.031	-0.081	-0.553	1.000	-0.014	0.006	0.058	0.020	0.185	0.064	0.064	-0.066
	(0.000)	(0.000)	(0.550)	(0.087)	(0.009)	(0.000)	(0.000)		(0.226)	(0.600)	(0.000)	(0.093)	(0.000)	(0.000)	(0.000)	(0.000)
$BigBath_{it}$	0.010	0.005	0.242	0.332	-0.080	0.005	-0.005	-0.008	1.000	0.302	-0.026	0.193	0.082	0.015	0.054	-0.044
	(0.380)	(0.647)	(0.000)	(0.000)	(0.000)	(0.677)	(0.694)	(0.516)		(0.000)	(0.030)	(0.000)	(0.000)	(0.200)	(0.000)	(0.000)
$IncSmooth_{it}$	-0.032	-0.040	0.180	0.202	-0.046	0.046	0.071	0.018	0.097	1.000	-0.105	0.209	-0.095	-0.014	0.072	-0.010
	(0.007)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.116)	(0.000)		(0.000)	(0.000)	(0.000)	(0.243)	(0.000)	(0.398)
dta_{it}	0.067	0.080	-0.135	-0.141	0.148	-0.066	-0.063	0.045	-0.011	-0.060	1.000	-0.069	0.297	0.078	0.096	-0.102
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.367)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Δgdp_{it}	-0.037	-0.048	0.092	0.069	-0.142	-0.037	-0.040	0.048	0.099	0.072	-0.030	1.000	0.027	0.022	0.052	-0.009
	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.010)		(0.020)	(0.061)	(0.000)	(0.441)
$size_{it}$	0.328	0.450	0.066	0.004	0.013	0.001	-0.055	0.188	0.104	-0.128	0.185	0.016	1.000	0.224	0.326	-0.343
	(0.000)	(0.000)	(0.000)	(0.751)	(0.252)	(0.909)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.165)		(0.000)	(0.000)	(0.000)
$big4_{it}$	0.118	0.136	0.021	0.013	-0.047	-0.015	-0.015	0.064	0.036	-0.018	0.062	0.043	0.224	1.000	0.117	0.112
	(0.000)	(0.000)	(0.075)	(0.267)	(0.000)	(0.204)	(0.214)	(0.000)	(0.002)	(0.118)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)
wo_prev_{it}	0.522	0.522	-0.058	-0.055	0.042	0.066	0.039	0.064	0.052	0.051	0.061	0.051	0.326	0.117	1.000	-0.951
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)
WO_prev_{it}	-0.477	0.489	0.031	0.042	-0.029	-0.046	-0.007	-0.066	-0.046	0.034	-0.054	-0.030	-0.340	-0.107	-0.921	1.000
	(0.000)	(0.000)	(0.009)	(0.000)	(0.014)	(0.000)	(0.544)	(0.000)	(0.000)	(0.003)	(0.000)	(0.012)	(0.000)	(0.000)	(0.000)	

Table B.7 exhibits the pairwise Pearson correlation coefficients in the lower left triangle. Pairwise Spearman correlation coefficients are provided in the upper right triangle. Significance levels are reported below in parentheses.

Table B.8: Basic regression results

	Cragg model N=7,268				Tobit model N=7,268
	Predicted Sign	Coefficient (Z-Statistic)	Predicted Sign	Coefficient (Z-Statistic)	Coefficient (Z-Statistic)
		Write-off decision		*Write-off magnitude*	*Overall-Model*
constant	+/-	-3.625***	+/-	5.800***	-14.969***
		(-16.190)		(12.630)	(-17.330)
roa_{it}	-	-0.023***	+	0.055***	-0.063***
		(-7.530)		(5.820)	(-7.340)
ocf_{it}	-	0.612**	+	-1.436*	1.312*
		(2.470)		(-1.680)	(1.890)
mtb_{it}	+	0.170***			0.512***
		(3.720)			(2.910)
ind_roa_{it}	-	0.091**	+	0.257***	0.492***
		(2.260)		(3.030)	(3.430)
ind_ocf_{it}	-	-1.192	+	-25.267***	-18.409**
		(-0.530)			(-2.230)
ind_mtb_{it}	+	-0.005			0.019
		(-0.120)			(0.120)
$BigBath_{it}$	-	-0.065	+	3.264**	0.772
		(-0.210)		(2.150)	(0.510)
$IncSmooth_{it}$	+	-0.453	-	-2.951***	-2.030*
		(-1.630)		(-3.260)	(-1.900)
dta_{it}	+/-	-0.001	+/-	0.002	-0.003
		(-1.370)		(0.590)	(-0.830)
Δgdp_{it}	-	-0.178	+	1.328*	0.218
		(-0.420)		(1.700)	(0.120)
$size_{it}$	+	0.179***	+	0.050**	0.811***
		(14.910)		(2.050)	(16.630)
$big4_{it}$	+	0.165***	+	-0.190	0.653***
		(2.890)		(-1.260)	(2.940)
wo_prev_{it}	+	1.496***			7.130***
		(15.020)			(18.050)
WO_prev_{it}	-	0.036**	+	-0.087***	-0.202***
		(2.470)		(-7.180)	(-4.520)
Sigma		1.748			4.960
Log Likelihood		-10,128.64			-12,057.07
Wald-statistic		0.000			0.000

Table B.8 displays the results of the basic regressions of the Cragg model and the Tobit model according to equations 3.4.1 and 3.4.2 with robust clustered standard errors. Results for the year dummies were not reported for the sake of readability. ***, ** and * denote significance at the <0.01, <0.05 and <0.1 levels respectively.

Table B.9: Results for the regression analysis by country clusters

	Predicted Sign	**All Countries** Coefficient (Z-Statistic) N=7,268	**Cluster 1: Outsider economies** Coefficient (Z-Statistic) N=1,585	**Cluster 2: Insider economies with strong enforcement** Coefficient (Z-Statistic) N=4,042	**Cluster 3: Insider economies with weak enforcement** Coefficient (Z-Statistic) N=1,589
Write-off decision					
constant	+/-	-3.625***	-4.448***	-3.645***	-2.918***
		(-16.190)	(-9.970)	(-10.880)	(-6.160)
roa_{it}	-	-0.023***	-0.018***	-0.025***	-0.029***
		(-7.530)	(-2.580)	(-6.940)	(-4.470)
ocf_{it}	-	0.612**	0.594	0.569*	1.325**
		(2.470)	(1.100)	(1.930)	(2.340)
mtb_{it}	+	0.170***	0.276***	0.145**	0.154*
		(3.720)	(2.730)	(2.190)	(1.750)
ind_roa_{it}	-	0.091**	0.102	0.098*	0.087
		(2.260)	(1.310)	(1.830)	(0.850)
ind_ocf_{it}	-	-1.192	2.018	-3.344	-1.709
		(-0.530)	(0.470)	(-1.040)	(-0.320)
ind_mtb_{it}	+	-0.005	0.058	-0.030	-0.101
		(-0.120)	(0.670)	(-0.470)	(-0.870)
$BigBath_{it}$	-	-0.065	-1.432	0.520	-0.366
		(-0.210)	(-1.570)	(0.930)	(-0.610)
$IncSmooth_{it}$	+	-0.453	-0.132	-0.764**	0.360
		(-1.630)	(-0.200)	(-2.230)	(0.520)
dta_{it}	+/-	-0.001	0.003	-0.002*	-0.001
		(-1.370)	(1.150)	(-1.880)	(-0.530)
Δgdp_{it}	-	-0.178	n.a.	0.663	-0.525
		(-0.420)	n.a.	(0.770)	(-0.270)
$size_{it}$	+	0.179***	0.175***	0.201***	0.135***
		(14910)	(6.550)	(12.220)	(5.110)
$big4_{it}$	+	0.165***	0.278	0.164**	0.235**
		(2.890)	(1.450)	(2.160)	(2.280)
wo_prev_{it}	+	1.496***	1.031***	1.644***	1.819***
		(15.020)	(4.840)	(11.980)	(7.980)
WO_prev_{it}	-	0.036**	-0.025	0.066***	0.063**
		(2.470)	(-0.680)	(3.310)	(2.040)

		All Countries	Cluster 1: Outsider economies	Cluster 2: Insider economies with strong enforcement	Cluster 3: Insider economies with weak enforcement
Write-off magnitude					
constant	+/-	5.800***	4.214***	5.556***	4.726***
		(12.630)	(3.960)	(8.550)	(3.550)
roa_{it}	+	0.055***	0.045**	0.058***	0.079***
		(5.820)	(2.320)	(6.170)	(3.780)
ocf_{it}	+	-1.436*	-2.048	-1.045	-1.645
		(-1.680)	(-1.270)	(-1.130)	(-1.070)
ind_roa_{it}	+	0.257***	0.238*	0.379***	0.007
		(3.030)	(1.820)	(3.420)	(0.030)
ind_ocf_{it}	+	-25.267***	-20.617***	-28.452***	-8.131
		(-4.940)	(-2.580)	(-4.080)	(-0.680)
$BigBath_{it}$	+	3.264**	3.701**	2.070	3.244
		(2.150)	(2.160)	(0.970)	(1.080)
$IncSmooth_{it}$	-	-2.951***	-2.093*	-2.096	-4.117*
		(-3.260)	(-1.720)	(-1.620)	(-1.670)
dta_{it}	+/-	0.002	-0.001	-0.001	0.001
		(0.590)	(-0.290)	(-0.330)	(0.150)
Δgdp_{it}	+	1.328*	n.a.	-1.194	-7.189*
		(1.700)	n.a.	(-0.880)	(-1.690)
$size_{it}$	+	0.050**	0.073	0.043	0.121**
		(2.050)	(1.390)	(1.380)	(2.040)
$big4_{it}$	+	-0.190	0.716	-0.073	-0.096
		(-1.260)	(0.880)	(-0.410)	(-0.300)
WO_prev_{it}	+	-0.087***	-0.068***	-0.073***	-0.078**
		(-7.180)	(-2.570)	(-4.690)	(-3.250)
Sigma		1.748	1.605	1.673	1.898
Log Likelihood		-10,128.64	-1,937.10	-5,824.04	-2,183.08
Wald-statistic		0.000	0.000	0.000	0.000

Table B.9 displays the results of our regression analyses by country cluster using the Cragg model with robust clustered standard errors. The results of the Cragg model for all countries are equal to those given in Table B.8 and serve as a reference only. Results for the year dummies were not reported for the sake of readability. ***, ** and * denote significance at the <0.01, <0.05 and <0.1 levels respectively.

Table B.10: Confirmation of hypotheses for regressions by country clusters

	All countries	Cluster 1: Outsider economies	Cluster 2: Insider economies with strong enforcement	Cluster 3: Insider economies with weak enforcement
H1a	+/-	+	+/-	+/-
H2a	-	∘	-	∘
H3a	∘	∘	- (I)	∘
H4a	∘	∘	+	∘
H1b	+/-	+	+	+
H2b	+/-	+/-	+/-	∘
H3b	+ (B,I)	+ (B,I)	∘	+ (I)
H4b	∘	∘	∘	∘

Table B.10 presents the confirmation of our hypotheses for the regressions by country cluster in condensed form. A hypothesis is confirmed (+) when we found support through at least one variable for this hypothesis. When we have no statistically significant results the hypothesis is neither confirmed nor rejected (∘). The hypothesis is rejected (-) when we found significant support against it. +/- indicates that we found support in favor of the hypothesis as well as against. For H3a and H3b we additionally indicated whether the hypothesis was confirmed/rejected based on big bath accounting (B), income smoothing (I) or both (B,I).

Table B.11: Results for the regression analysis by country clusters for two periods

Write-off decision	Predicted Sign	**Cluster 1: Outsider economies** 2005-2008	2009-2011	**Cluster 2: Insider economies with strong enforcement** 2005-2008	2009-2011	**Cluster 3: Insider economies with weak enforcement** 2005-2008	2009-2011
		Coefficient (Z-Statistic) N=703	Coefficient (Z-Statistic) N=882	Coefficient (Z-Statistic) N=2,014	Coefficient (Z-Statistic) N=2,028	Coefficient (Z-Statistic) N=762	Coefficient (Z-Statistic) N=827
constant	+/-	-4.707***	-4.276***	-3.721***	-3.355***	-3.772***	-2.347***
		(-7.130)	(-7.870)	(-8.420)	(-8.080)	(-5.080)	(-4.000)
roa_{it}	-	-0.022***	-0.014	-0.025***	-0.030***	-0.027**	-0.027***
		(-2.670)	(-1.550)	(-5.580)	(-5.620)	(-2.460)	(-2.660)
ocf_{it}	-	0.367	1.061	0.884***	0.478	1.378*	1.043
		(0.520)	(1.290)	(2.900)	(1.220)	(1.730)	(1.180)
mtb_{it}	+	0.472***	0.184	0.184*	0.110	0.077	0.186*
		(2.940)	(1.350)	(1.800)	(1.330)	(0.510)	(1.750)
ind_roa_{it}	-	-0.015	0.174*	0.078	0.123*	0.239*	-0.054
		(-0.140)	(1.920)	(1.160)	(1.890)	(1.800)	(-0.420)
ind_ocf_{it}	-	6.820	-1.813	-1.954	-5.170	-2.848	-0.197
		(1.170)	(-0.350)	(-0.480)	(-1.340)	(-0.400)	(-0.030)
ind_mtb_{it}	+	0.105	0.003	-0.063	-0.003	-0.094	-0.109
		(0.850)	(0.030)	(-0.840)	(-0.030)	(-0.600)	(-0.790)
$BigBath_{it}$	-	-0.926	-2.213	1.391*	-0.152	-0.274	-1.318
		(-0.800)	(-1.480)	(1.780)	(-0.250)	(-0.260)	(-0.770)
$IncSmooth_{it}$	+	0.603	-0.617	-0.739	-0.781*	0.188	1.209
		(0.450)	(-0.990)	(-1.580)	(-1.650)	(0.280)	(0.840)
dta_{it}	+/-	-0.003	0.008**	-0.002	-0.003	0.001	-0.003
		(-0.780)	(2.350)	(-0.880)	(-1.590)	(0.240)	(-1.130)
Δgdp_{it}	-	n.a.	n.a.	-0.001	0.948	-5.883	1.628
		n.a.	n.a.	(0.000)	(1.020)	(-1.560)	(0.610)
$size_{it}$	+	0.203***	0.159***	0.219***	0.185***	0.139***	0.139***
		(5.290)	(4.770)	(10.210)	(8.220)	(3.890)	(4.140)
$big4_{it}$	+	0.402	0.136	0.191**	0.131	0.093	0.283*
		(1.190)	(0.600)	(2.050)	(1.360)	(0.610)	(1.850)
wo_prev_{it}	+	1.079***	1.070***	1.808***	1.500***	1.765***	1.817***
		(2.830)	(4.300)	(9.730)	(8.130)	(5.080)	(6.300)
WO_prev_{it}	-	-0.011	-0.025	0.095***	0.037	0.073	0.048
		(-0.170)	(-0.570)	(3.590)	(1.300)	(1.520)	(1.180)

Write-off magnitude		Cluster 1: Outsider economies 2005-2008	Cluster 1: Outsider economies 2009-2011	Cluster 2: Insider economies with strong enforcement 2005-2008	Cluster 2: Insider economies with strong enforcement 2009-2011	Cluster 3: Insider economies with weak enforcement 2005-2008	Cluster 3: Insider economies with weak enforcement 2009-2011
constant	+/-	4.487***	3.844***	6.840***	4.684***	2.663	6.460***
		(2.020)	(3.140)	(7.180)	(6.540)	(1.300)	(4.570)
roa_{it}	+	0.064***	0.036	0.071***	0.054***	0.087***	0.087***
		(4.100)	(1.400)	(5.710)	(4.690)	(3.670)	(2.840)
ocf_{it}	+	-2.596	-2.152	-1.123	-1.230	-5.016**	1.571
		(-1.260)	(-1.010)	(-1.210)	(-1.100)	(-2.520)	(0.780)
ind_roa_{it}	+	0.174	0.320*	0.417**	0.326***	0.093	-0.091
		(0.860)	(1.950)	(2.540)	(2.590)	(0.340)	(-0.410)
ind_ocf_{it}	+	-13.666	-24.713**	-35.145***	-21.609***	-5.302	-9.201
		(-1.230)	(-2.370)	(-3.410)	(-2.900)	(-0.330)	(-0.710)
$BigBath_{it}$	+	3.439	2.552	-1.505	4.650**	4.261	1.180
		(1.440)	(0.750)	(-0.480)	(2.520)	(1.100)	(0.320)
$IncSmooth_{it}$	-	-6.987***	0.550	-6.654***	-0.651	-5.845*	-3.794
		(-4.450)	(0.500)	(-3.390)	(-0.540)	(-1.930)	(-1.280)
dta_{it}	+/-	0.006	-0.008	-0.004	0.001	0.001	0.004
		(0.690)	(-1.350)	(-0.680)	(0.150)	(0.120)	(0.450)
Δgdp_{it}	+	n.a.	n.a.	-5.894	-0.473	-5.679	-4.066
		n.a.	n.a.	(-1.310)	(-0.360)	(-0.650)	(-0.700)
$size_{it}$	+	0.012	0.091	0.017	0.057*	0.248***	0.036
		(0.210)	(1.400)	(0.390)	(1.680)	(3.080)	(0.510)
$big4_{it}$	+	0.512	1.018	-0.385	0.183	0.695*	-0.514
		(0.240)	(1.170)	(-1.360)	(1.030)	(1.670)	(-1.100)
WO_prev_{it}	+	-0.125***	-0.029	-0.070***	-0.076***	-0.005	-0.122***
		(-3.450)	(-0.790)	(-3.060)	(-3.620)	(-0.140)	(-3.070)
Sigma		1.543	1.594	1.752	1.570	1.771	1.930
Log Likelihood		-768.01	-1,149.73	-2,822.77	-2,969.60	-919.86	-1,242.87
Wald-statistic		0.000	0.000	0.000	0.000	0.000	0.000

Table B.11 displays the results of our regression analyses by country cluster and for two periods using the Cragg model with robust clustered standard errors. Results for the year dummies were not reported for the sake of readability. ***, ** and * denote significance at the <0.01, <0.05 and <0.1 levels respectively.

Table B.12: Regression results by industry

Write-off decision		**All Industries**	**Services**	**Manufacturing**	**Transportation, Communications, Electric, Gas and Sanitary Services**	**Retail Trade**	**Wholesale Trade**	**Construction**	**Mining**
	Predicted Sign	Coefficient (Z-Statistic) N=7,268	Coefficient (Z-Statistic) N=1,211	Coefficient (Z-Statistic) N=3,499	Coefficient (Z-Statistic) N=1,009	Coefficient (Z-Statistic) N=406	Coefficient (Z-Statistic) N=283	Coefficient (Z-Statistic) N=452	Coefficient (Z-Statistic) N=333
constant	+/-	-3.625***	-2.825***	-3.872***	-3.270***	-3.428**	-3.793***	-1.545**	-2.358***
		(-1.190)	(-5.910)	(-14.730)	(-6.660)	(-3.660)	(-2.880)	(-2.240)	(-3.780)
roa_{it}	-	-0.023***	-0.032***	-0.030***	-0.026***	-0.070***	-0.019	-0.034	-0.007
		(-7.530)	(-4.820)	(-8.210)	(-2.810)	(-2.690)	(-1.600)	(-1.640)	(-1.110)
ocf_{it}	-	0.612**	1.795***	0.425*	1.819**	5.385***	0.398	0.746	0.007
		(2.470)	(3.580)	(1.700)	(2.270)	(2.740)	(0.320)	(0.380)	(0.010)
mtb_{it}	+	0.170***	0.267**	0.136**	0.081	0.500**	0.375*	0.041	0.145
		(3.720)	2.350)	(2.060)	(0.650)	(1.970)	(1.880)	(0.250)	(0.650)
$BigBath_{it}$	-	-0.065	-0.380	0.093	0.239	-0.437	1.708	0.521	-0.986
		(-0.210)	(-0.420)	(0.150)	(0.190)	(-0.110)	(0.600)	(0.190)	(-0.610)
$IncSmooth_{it}$	+	-0.453	-0.797	-0.097	-0.011	-0.230	-6.230*	-2.185	-0.724
		(-1.630)	(-1.280)	(-0.260)	(-0.010)	(-0.070)	(-1.840)	(-1.350)	(-0.950)
dta_{it}	+/-	-0.001	0.001	0.000	-0.007**	0.008	-0.007	-0.004	0.000
		(-1.370)	(0.570)	(-0.090)	(-2.410)	(1.190)	(-1.000)	(-0.920)	(0.000)
Δgdp_{it}	-	-0.178	0.166	-0.024	0.062	1.468	-0.714	-1.511	-5.299***
		(-0.420)	(0.190)	(-0.030)	(0.050)	(0.820)	(-0.350)	(-0.970)	(-3.110)
$size_{it}$	+	0.179***	0.141***	0.233***	0.172***	0.136**	0.216**	0.088*	0.130
		(14.910)	(3.830)	(12.470)	(5.630)	(2.060)	(2.230)	(1.770)	(3.070)
$big4_{it}$	+	0.165***	0.177	0.165*	0.296	0.198	0.266	0.004	0.100
		(2.890)	(1.270)	(1.910)	(1.550)	(0.910)	(0.720)	(0.020)	(0.410)
wo_prev_{it}	+	1.496***	1.098***	1.452***	1.834***	2.186**	1.711***	1.514***	1.417***
		(15.020)	(4.420)	(10.040)	(6.650)	(4.490)	(2.740)	(3.150)	(3.140)
WO_prev_{it}	-	0.036**	-0.037	0.047**	0.077**	0.098	0.001	0.019	-0.005
		(2.470)	(-0.900)	(2.240)	(1.960)	(1.350)	(0.010)	(0.270)	(-0.060)

Write-off magnitude		All Industries	Services	Manufacturing	Transportation, Communications, Electric, Gas and Sanitary Services	Retail Trade	Wholesale Trade	Construction	Mining
constant	+/-	5.800***	3.308***	5.097***	5.218***	6.967***	5.824***	3.136**	4.209***
		(12.630)	(2.660)	(9.810)	(5.500)	(4.430)	(3.860)	(1.960)	(3.640)
roa_{it}	+	***	0.052***	0.067***	0.075***	0.162***	0.208***	0.096**	0.022
		(5.820)	(3.170)	(7.320)	(3.390)	(5.250)	(5.830)	(2.090)	(1.120)
ocf_{it}	+	-1.436*	-4.276***	-0.706	-2.672	-11.395***	-7.373*	1.120	0.273
		(-1.680)	(-3.380)	(-0.790)	(-1.300)	(-4.590)	(-1.720)	(0.370)	(0.120)
$BigBath_{it}$	+	3.264**	6.297**	0.997	2.606	20.146***	8.529*	9.010*	-2.800
		(2.150)	(1.990)	(0.450)	(0.900)	(3.100)	(1.860)	(1.950)	(-1.030)
$IncSmooth_{it}$	-	-2.951***	0.583	-3.399***	-4.038**	-9.060***	-15.086***	-6.885*	-0.516
		(-3.260)	(0.370)	(-3.130)	(-2.110)	(-3.020)	(-2.930)	(-1.910)	(-0.250)
dta_{it}	+/-	0.002	-0.009	-0.002	0.011	0.001	0.021	0.025**	0.012
		(0.590)	(-1.440)	(-0.360)	(1.640)	(0.160)	(1.270)	(2.520)	(0.890)
Δgdp_{it}	+	1.328*	-0.526	0.802	-0.601	4.860**	1.582	-3.058	1.016
		(1.700)	(-0.220)	(0.700)	(-0.250)	(2.380)	(0.450)	(-1.200)	(0.270)
$size_{it}$	+	0.050**	0.179*	0.017	-0.001	-0.022	-0.078	0.174*	0.047
		(2.050)	(1.930)	(0.500)	(-0.010)	(-0.210)	(-0.780)	(1.660)	(0.480)
$big4_{it}$	+	-0.190	-0.343	0.023	-0.129	-0.934*	0.427	-0.409	-0.087
		(-1.260)	(-0.920)	(0.110)	(-0.470)	(-1.720)	(0.530)	(-0.580)	(-0.210)
WO_prev_{it}	+	-0.087***	-0.088***	-0.073***	-0.065**	-0.125***	-0.080*	-0.094**	-0.054
		(-7.180)	(-2.710)	(-4.160)	(-2.170)	(-3.280)	(-1.770)	(-2.250)	(-0.820)
Sigma		1.748	1.775	1.725	1.706	1.421	1.425	1.637	1.837
Log Likelihood		-10,128.64	-1,428.41	-5,011.17	-1,408.12	-578.69	-317.19	-599.53	-491.83
Wald-statistic		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table B.12 exhibits the results of the regression analyses by industry applying the Cragg model with robust clustered standard errors. Industry is defined in accordance with the SIC code divisions. We did not include the industry Agriculture, Forestry and Fishing in the analysis as we have only 75 firm-years in our sample that belong to this industry. We do not have any observations in our sample that belong to the sectors Finance, Insurance and Real Estate or Public Administration; see Table B.1. The results of the Cragg model for all countries are equal to those given in Table B.8 and serve as a reference only. Results for the year dummies were not reported for the sake of readability. ***, ** and * denote significance at the <0.01, <0.05 and <0.1 levels respectively.

Table B.13: Confirmation of hypotheses for regressions by industry

	All Industries	**Services**	**Manufacturing**	**Transportation, Communications, Electric, Gas and Sanitary Services**	**Retail Trade**	**Wholesale Trade**	**Construction**	**Mining**
H1a	+/-	+/-	+/-	+/-	+/-	+	○	○
H2a	-	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
H3a	○	○	○	○	○	- (I)	○	○
H4a	○	○	○	+	○	○	○	○
H1b	+/-	+/-	+	+	+/-	+/-	+	○
H2b	+/-	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
H3b	+ (B,I)	+ (B)	+ (I)	+ (I)	+ (B,I)	+ (B,I)	+ (B,I)	○
H4b	○	○	○	○	○	○	+	○

Table B.13 presents the confirmation of our hypotheses for the regressions by industry in condensed form. A hypothesis is confirmed (+) when we found support through at least one variable for this hypothesis. When we have no statistically significant results the hypothesis is neither confirmed nor rejected (○). The hypothesis is rejected (-) when we found significant support against it. +/- indicates that we found support in favor of the hypothesis as well as against. For H3a and H3b we additionally indicated whether the hypothesis was confirmed/rejected based on big bath accounting (B), income smoothing (I) or both (B,I).

Table B.14: Regression results by type of write-off

	Predicted Sign	**All write-offs** Coefficient (Z-Statistic) N=7,268	**Write-offs of goodwill** Coefficient (Z-Statistic) N=7,268	**Write-offs of other intangible assets** Coefficient (Z-Statistic) N=7,268	**Write-offs of property, plant and equipment** Coefficient (Z-Statistic) N=7,268
Write-off decision					
constant	+/-	-3.625***	-2.526***	-3.865***	-4.356***
		(-16.190)	(-10.810)	(-15.590)	(-18.840)
roa_{it}	-	-0.023***	-0.029***	-0.016***	-0.018***
		(-7.530)	(-7.370)	(-4.550)	(-6.850)
ocf_{it}	-	0.612**	1.085***	0.473*	0.338
		(2.470)	(3.020)	(1.820)	(1.530)
mtb_{it}	+	0.170***	0.147***	-0.039	0.190***
		(3.720)	(2.910)	(-0.760)	(4.170)
ind_roa_{it}	-	0.091**	-0.042	-0.050	0.191***
		(2.260)	(-0.940)	(-1.100)	(4.530)
ind_ocf_{it}	-	-1.192	-1.544	7.349***	-4.538*
		(-0.530)	(-0.590)	(2.770)	(-1.940)
ind_mtb_{it}	+	-0.005	-0.242***	0.103**	0.091*
		(-0.120)	(-4.910)	(1.980)	(1.840)
$BigBath_{it}$	-	-0.065	1.034*	-0.446*	-0.292
		(-0.210)	(2.040)	(-1.810)	(-1.130)
$IncSmooth_{it}$	+	-0.453	-1.176***	-0.099	-0.161
		(-1.630)	(-3.230)	(-0.300)	(-0.540)
dta_{it}	+/-	-0.001	-0.003***	-0.002	0.001
		(-1.370)	(-2.670)	(-1.630)	(0.860)
Δgdp_{it}	-	-0.178	-0.330	-0.825*	0.578
		(-0.420)	(-0.680)	(-1.650)	(1.280)
$size_{it}$	+	0.179***	0.147***	0.140***	0.165***
		(14.910)	(11.680)	(10.730)	(13.340)
$big4_{it}$	+	0.165***	-0.066	0.222***	0.248***
		(2.890)	(-0.980)	(3.050)	(3.870)
wo_prev_{it}	+	1.496***	1.229***	1.790***	1.599***
		(15.020)	(8.830)	(11.660)	(13.240)
WO_prev_{it}	-	0.036**	0.004	0.048**	0.022
		(2.470)	(0.180)	(2.260)	(1.270)

Write-off magnitude		**All write-offs**	**Write-offs of goodwill**	**Write-offs of other intangible assets**	**Write-offs of property, plant and equipment**
constant	+/-	5.800***	2.608***	4.549***	6.748***
		(12.630)	(3.440)	(4.660)	(12.560)
roa_{it}	+	0.055***	0.073***	0.026***	0.037***
		(5.820)	(6.200)	(2.800)	(4.500)
ocf_{it}	+	-1.436*	-1.604	-0.067	-1.588**
		(-1.680)	(-1.450)	(-0.080)	(-2.370)
ind_roa_{it}	+	0.257***	0.518***	0.470***	-0.058
		(3.030)	(3.830)	(2.920)	(-0.630)
ind_ocf_{it}	+	-25.267***	-32.530***	-41.333***	-9.206
		(-4.940)	(-4.140)	(-3.840)	(-1.540)
$BigBath_{it}$	+	3.264**	0.985	2.602	4.014***
		(2.150)	(0.270)	(1.410)	(3.280)
$IncSmooth_{it}$	-	-2.951***	-2.710	-2.845***	-1.791**
		(-3.260)	(-1.510)	(-3.260)	(-2.200)
dta_{it}	+/-	0.002	0.004	0.000	0.000
		(0.590)	(0.950)	(0.050)	(-0.080)
Δgdp_{it}	+	1.328*	2.183*	1.837	1.709*
		(1.700)	(1.680)	(1.290)	(1.880)
$size_{it}$	+	0.050**	0.182***	0.222***	0.065**
		(2.050)	(4.240)	(5.750)	(2.410)
$big4_{it}$	+	-0.190	-0.014	-0.131	-0.350*
		(-1.260)	(-0.070)	(-0.400)	(-1.800)
WO_prev_{it}	+	-0.087***	-0.100***	-0.060***	-0.076***
		(-7.180)	(-5.500)	(-3.230)	(-5.750)
Sigma		1.748	1.794	1.885	1.706
Log Likelihood		-10,128.64	-4,960.16	-5,065.87	-7,853.32
Wald-statistic		0.000	0.000	0.000	0.000

Table B.14 exhibits the result of the regression analyses by type of write-off applying the Cragg model with robust clustered standard errors. The results of the Cragg model for all countries are equal to those given in Table B.8 and serve as a reference only. Results for the year dummies were not reported for the sake of readability. ***, ** and * denote significance at the <0.01, <0.05 and <0.1 levels respectively.

Table B.15: Confirmation of hypotheses for regressions by type of write-off

	All write-offs	**Write-offs of goodwill**	**Write-offs of other intangible assets**	**Write-offs of property, plant and equipment**
H1a	+/-	+/-	+/-	+
H2a	-	-	+/-	+/-
H3a	∘	-	+ (B)	∘
H4a	∘	+	∘	∘
H1b	+/-	+	+	+/-
H2b	+/-	+/-	+/-	∘
H3b	+ (B,I)	∘	+ (I)	+ (B,I)
H4b	∘	∘	∘	∘

Table B.15 presents the confirmation of our hypotheses for the regressions by type of write-off in condensed form. A hypothesis is confirmed (+) when we found support through at least one variable for this hypothesis. When we have no statistically significant results the hypothesis is neither confirmed nor rejected (∘). The hypothesis is rejected (-) when we found significant support against it. +/- indicates that we found support in favor of the hypothesis as well as against. For H3a and H3b we additionally indicated whether the hypothesis was confirmed/rejected based on big bath accounting (B), income smoothing (I) or both (B,I).

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4 A Critical Analysis of the Requirements of IAS 36 – A Pre-Tax CAPM?

Chapter contents

A Critical Analysis of the Requirements of IAS 36 – A Pre-Tax CAPM?

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Abstract IAS 36 *Impairment of Assets* requires the discounting of future cash flows when calculating the value in use. These cash flows are expected to result from the further use and the disposal of the asset under consideration. IAS 36 prescribes the use of a pre-tax discount rate which is independent of the capital structure. How this discount rate is to be determined has been widely discussed but no theoretically convincing answer has yet been found. In this paper we show that the pre-tax cost of equity of the unlevered firm fulfills the requirements of IAS 36. While the calculation of the unlevered cost of capital is a commonly known technique, until now there has not been a theory for the calculation of the pre-tax cost of equity. Therefore, we derive the return equation of a variation of the CAPM in which corporate taxes are explicitly considered. However, this return equation entails some parameters that will be hard to determine in practice. We recommend a revision of the regulations concerning the calculation of the value in use to reduce managerial discretion as well as application problems.

4.1 Introduction

Write-offs are usually very important in the calculation of net profit according to the *International Financial Reporting Standards* (IFRS).[1] This is why the regulations concerning the recognition of write-offs attract attention from theoreticians and practitioners, alike. A number of empirical analyses found that managerial discretion inherent in the recognition and measurement of fixed asset write-offs is used for earnings management.[2] IAS 36 *Impairment of Assets* contains extensive guidance on when write-offs have to be recognized and what amount has to be written off. Managerial discretion mainly arises because the recoverable amount – which is the central measure of IAS 36 – requires the forecasting and discounting of future cash flows. More specifically, the recoverable amount is defined as the higher value of the fair value less costs to sell and the value in use. While the calculation of the fair value less costs to sell is straightforward – although not simple – following a fair value hierarchy, the calculation of the value in use involves some difficulties. One of these is that the definition of the discount rate that has to be used entails some puzzling and conflicting requirements. Interestingly, this matter has been discussed very little until now. The aim of this paper is to illustrate the complex and maybe unrealizable requirements of IAS 36 concerning the discount rate that has to be deployed to calculate the value in use. For this purpose we derive a model that is theoretically suited to IAS 36 but has a number of practical problems. Our recommendation to the *International Accounting Standards Board*

[1] For example, in 2008, the E.On Group recognized a write-off in the amount of 3,626 m EUR in the consolidated financial statements corresponding to a net profit in the amount of 1,604 m EUR. Similarly, the Deutsche Telekom Group recognized a write-off in the amount of 2,555 m EUR in the 2009 consolidated financial statements, corresponding to a net profit of 873 m EUR. See *E.ON AG* (2008), pp. 96-99 and *Deutsche Telekom AG* (2009), pp. 156-160.

[2] Empirical analyses have mainly been conducted for the US market. As both US-GAAP and IFRS entail similar managerial discretion, the mere finding that this discretion is used opportunistically should be transferable. See, for example, *Riedl* (2004) or *Beatty* and *Weber* (2006).

(IASB) is to revise the regulations concerning the calculation of the value in use so as to reduce practical problems as well as managerial discretion.

The outline of the paper is as follows. In section 4.2 we describe the rules relevant for the determination of the value in use. In section 4.3 we give a short literature review. As prior research is scarce we additionally review the guidance given in the commentaries of the big four audit companies, which should give insights from a practical perspective. In section 4.4 we derive the model implied by the requirements of IAS 36; section 4.5 summarizes and concludes.

4.2 The Requirements of IAS 36

4.2.1 Calculation of the Value in Use

Following the rules of IAS 36, a qualitative impairment test has to be conducted annually in which the firm has to analyze whether there are any indications that the asset under consideration may be impaired.[3] If there are such indications a quantitative impairment test has to be conducted in which the recoverable amount has to be calculated and then compared to the carrying amount. The recoverable amount is defined by IAS 36.6 as the higher value of the fair value less costs to sell and the value in use. As the focus of this paper is the derivation of the discount rate for the calculation of the value in use, we only briefly present the basic regulations concerning the determination of the cash flows for the value in use, instead delving a little deeper into those rules concerning the discount rate.

[3] According to IAS 36.66, the impairment test shall basically be conducted for the single asset. Only if the recoverable amount cannot be determined is the impairment test conducted on the level of the asset's cash-generating unit as defined in IAS 36.6. For the rest of this paper we will talk about assets for reasons of simplicity, but it should be noted that our results can be applied to cash-generating units as well.

IAS 36.6 defines the value in use as "the present value of the future cash flows expected to be derived from an asset (...)". Detailed guidelines for the determination of the cash flows and the discount rate and two alternative techniques for calculating the present value are given. In summary, the cash flows from the further use of the asset assuming unaltered use and the cash flows from the disposal have to be used; the cash flows have to be before taxes and independent of the capital structure.

According to IAS 36.32 and 36.A2, the present value may be calculated using either the traditional approach – in which the most probable cash flows have to be discounted with a discount rate that reflects all risk – or the expected cash flow approach – in which the expected cash flows are discounted with a discount rate that reflects only those risks for which the cash flows have not been adjusted. As it is the more common – and, according to IAS 36.A7, the more effective – measurement tool, we focus on the expected cash flow approach.

Following IAS 36.55 a pre-tax rate is to be used to discount the cash flows.[4] While the cash flows have to be derived from corporate planning, the discount rate is supposed to reflect market assessments of the time value of money and the risks specific to the asset. According to IAS 36.A19, the discount rate has to be independent of the capital structure and the way the firm financed the purchase of the asset.

This discount rate shall be derived from an asset that is similar with respect to potential of use and risk structure.[5] Only if this is not possible does the firm have to estimate the discount rate. IAS 36.A17 gives three alternatives that may be used as

[4]IAS 36 does not explicitly specify *which* taxes shall not be reflected in the discount rate. In contrast, regarding the estimation of cash flows, IAS 36.50 requires that income taxes may not be included. As the cash flows and the discount rate should be determined consistently, we assume that the discount rate has to be a rate before income taxes – at the level of the company as well as at the private level – for our analysis.

[5]See IAS 36.56.

starting points for this estimation:

- the entity's weighted average cost of capital (WACC) determined using techniques such as the Capital Asset Pricing Model (CAPM);
- the entity's incremental borrowing rate; and
- other market borrowing rates.

These three rates have to be adjusted to "reflect the way the market would assess the specific risk associated with the asset's estimated cash flows and to exclude risks that are not relevant to the asset's estimated cash flows or for which the estimated cash flows have been adjusted".[6]

The *Basis for Conclusion* to IAS 36 outlines two approaches for the calculation of a pre-tax rate from a post-tax rate. IAS 36.BCZ85 states that "in theory, discounting post-tax cash flows at a post-tax discount rate and discounting pre-tax cash flows at a pre-tax discount rate should give the same result (...)". Under this assumption the pre-tax rate can be determined from the post-tax rate by applying an iterative procedure. The second approach is called grossing up and entails the simple division of the pre-tax rate by *(1-tax rate)*. However, in the example presented in IAS 36.BCZ85 the IASB declares that the pre-tax rate calculated by grossing up does not always equal the correct pre-tax rate – which is the one calculated using the iterative procedure – but only if constant cash flows are realized.

4.2.2 A short Note on the Requirements of IAS 36

The definition of the recoverable amount as the higher amount of the fair value less costs to sell and the value in use is supposed to reflect the rational calculus of the

[6] See IAS 36.A18.

manager, who should only retain the asset if further use produces higher value than the sale of the asset. Having said this, it seems inconsistent that IAS 36 requires a pre-tax calculation of the value in use as the rational investor – or in this case the rational manager – will include only post-tax measures in his decisional calculus. However, the aim of this paper is not to discuss whether the rules of IAS 36 are in line with rational behavior, but rather to analyze what a discount rate that fulfills the requirements might look like.

For the calculation of the value in use, a pre-tax discount rate shall be determined that is independent of the capital structure. The three rates that are presented as possible starting points surely depend on the capital structure, and at least the WACC is after taxes. The approaches presented in the appendix of IAS 36 to derive the pre-tax rate from the post-tax rate crucially depend on the basic assumption that the value in use calculated by discounting post-tax cash flows with a post-tax discount rate should equal the value in use calculated by discounting pre-tax cash flows with a pre-tax discount rate. However, this relationship holds only if a specific tax system applies that is neutral with regard to different investment alternatives.[7] Such a tax system does not apply in any of the countries of the European Union. Hence, the assumption of the equality of the pre-tax and post-tax calculations is not reflected in actual tax systems. Additionally, the rationale of requiring a pre-tax calculation based on a post-tax calculation is not clear, especially because the post-tax calculation would be in line with actual finance theory.

[7] See *Husmann*, *Schmidt* and *Seidel* (2002). A tax system is neutral with regard to different investment alternatives if the investment decision made on the basis of the net present value criterion is not altered if taxes are introduced, i.e. if the order of the net present values of the projects under consideration is the same before and after taxes. An equal present value before and after taxes only results from very specific tax systems that are neutral with regard to different investment alternatives; see *Kruschwitz*, *Husmann* and *Schneider* (2002).

Maybe even more interesting is the fact that the second requirement – the independence of the capital structure – is not discussed either in the main text or in the appendices of IAS 36. Hence, the user has to develop his own technique to adjust the discount rate with regard to the influences of the capital structure.

4.3 Literature Review

In this section we outline the recommendations of the existing literature regarding the derivation of the discount rate for the calculation of the value in use. Because theoretical literature is scarce we additionally discuss the positions of the big four audit companies, *Deloitte*, *Ernst & Young*, *KPMG* and *PwC*, as presented in their respective commentaries. Due to their practical experience and policy work on accounting issues we hope to gather insights into the solutions applied in practice. We discuss the independence of the capital structure and the use of a pre-tax rate separately in the next two subsections as we believe that these are the theoretically most crucial requirements. The essential task following from this discussion will be to incorporate taxes in the classical CAPM. Therefore, in the third subsection we briefly explain why the Tax-CAPMs are not suitable for this task.

4.3.1 Independence of the Capital Structure

According to *Pellens et al.* (2005), 76 % of German firms listed in the Prime Standard use the WACC to calculate the value in use. 20 % use rates derived from the sector and 11 % use the cost of equity.[8] A European survey conducted by *KPMG* regarding the impairment test elaborates only on the determination of those factors required to

[8]See *Pellens et al.* (2005), p. 16.

calculate the WACC,[9] indicating that most of the firms analyzed use the WACC to calculate the value in use.

As already noted, analytical discussion regarding the rules of IAS 36 is scarce. The only one we are aware of is that between *Husmann and Schmidt* and *Kvaal*. This discussion is based on the assumption that the Modigliani-Miller theorem holds, resulting in WACC that is independent of the capital structure.[10] *Husmann* and *Schmidt* (2008) compare the three discount rates given as starting points in IAS 36.A17. They first discard the other market borrowing rates from their analysis due to the vague formulation, and then use option pricing theory to derive a relation between the WACC and the incremental borrowing rate. They find that these two rates vary significantly and argue that – since from the perspective of finance theory the WACC is the only appropriate rate for the calculation of the value in use – the options to use the incremental borrowing rate or other market borrowing rates should be deleted. *Kvaal* (2010), on the other hand, argues against this because he deems their definition of the incremental borrowing rate to be inadequate and shows that, when using an appropriate definition, the incremental borrowing rate can be seen as a good second-best solution, especially if one considers that the CAPM could not hold. *Husmann* and *Schmidt* (2011) argue in response that the mere fact that *Kvaal* supposes a different definition for the incremental borrowing rate than they do emphasizes the managerial discretion that follows from the option to choose this rate as a starting point. Additionally, they explain that the validity of WACC does not depend on the calculation of the cost of equity using the CAPM, but that other approaches can be used as well.

There are two points worth emphasizing in this discussion. First, it is based on the

[9]See *KPMG* (2010), pp. 32-44.

[10]*Modigliani* and *Miller* (1958) proove that without taxes the market value of a firm as well as its WACC are independent of its capital structure.

assumption that the Modigliani-Miller theorem holds, necessitating a world without taxes. However, it does not follow from the requirement to calculate a pre-tax value in use that we operate in a world without taxes, because managers as well as investors will include taxes in their decisional calculus independent of the requirements of IAS 36. Second, the argumentation is driven by what is appropriate according to finance theory, in contrast to what the rules of IAS 36 require. In the model we derive in section 4.4, we will neither require a world without taxes nor consider what finance theory deems to be appropriate. Instead we will be guided solely by the requirements of IAS 36.

Regarding the opinions of the big four audit companies, the assumption that WACC is the discount rate usually applied is confirmed.[11] Regarding whether this is in line with the requirement of a discount rate that is independent of the capital structure, we find guidance only from *KPMG* and *Ernst & Young*. *KPMG* (2011) section 3.10.300.70 states that, as the discount rate shall be independent of the entity's capital structure, the gearing and the cost of debt of a market participant assumed to invest in the asset must be used. Similarly, in the example depicted in *Ernst & Young* (2013) section 22.4.5, the average gearing of companies operating predominantly in the same industry as the cash-generating unit is deployed, while the cost of debt and the cost of equity of a hypothetical listed company with a similar risk profile as the cash-generating unit are used. This approach, while practically appealing, is theoretically questionable as it still results in a discount rate that depends on the capital structure, although not on that of the company. In section 4.4.2 we will discuss why such a method is superfluous.

The Modigliani-Miller theorem does not hold in a world with taxes. From this fact we state that it therefore cannot be used here. Nevertheless, if the Modigliani-Miller theorem is not applied then the WACC depends on the capital structure and

[11] See *KPMG* (2011) section 3.10.300.30, *Ernst & Young* (2013) section 22.4.5 and *PwC* (2013) section 18.214.

thus cannot be used to calculate the value in use. The fact that the WACC is one of the suggested starting points of IAS 36.A17 cannot be held against this because, while IAS 36.A17 gives only possible starting points[12], IAS 36.A19 strictly requires the independence of the capital structure.[13] In reality, i.e. in a world with taxes, true independence of the discount rate of the capital structure may even be impossible to constitute, because an assumption regarding the capital structure is required for the calculation of WACC as well as for the isolated consideration of the cost of debt or cost of equity. Therefore, we interpret IAS 36.A19 as the requirement that the actual capital structure and changes therein shall have no influence on the discount rate. This can either be achieved by using the cost of equity of a (fictitiously) unlevered firm, or by using the cost of debt of a firm (fictitiously) financed completely with debt.[14] As there is a theory only for the first approach, we recommend the former.

4.3.2 Calculating a Pre-Tax Rate

In the survey conducted by *KPMG* it was found that 85 % of the companies that calculate the value in use apply a post-tax calculation. Only 68 % of these companies derive the pre-tax rate from this post-tax rate.

Theoretical discussion regarding the derivation of a pre-tax discount rate is even more scarce than works discussing the independence of the capital structure. *Husmann*, *Schmidt* and *Seidel* (2002) analyze the value in use based on a finance perspective. They explain that the present value before taxes equals that after taxes only in

[12]See IAS 36.A17: "As a starting point in making such an estimate, the entity might take into account (...)".

[13]See IAS 36.A19: "The discount rate is independent of the entity's capital structure (...)".

[14]If there is only one financier, the required return should be independent of the form of financing and both (fictitious) forms of the cost of capital were equal. If there is more than one financier this relation does not necessarily hold due to the increasing risk of insolvency.

specific tax systems that are neutral with regard to different investment alternatives. Additionally, they point out that the IASB's intention to reflect the decisional calculus in the definition of the recoverable amount is negated by introducing this pre-tax calculus. As a rational investor will decide based on post-tax numbers, the pre-tax calculation may lead to irrational decisions. While their critique is certainly apt, they do not suggest a discount rate that is in line with IAS 36. Similarly, *Kvaal* (2007) compares the two approaches presented in IAS 36.BCZ85 to derive the pre-tax discount rate from the post-tax discount rate. In line with IAS 36 he assumes that the pre-tax discount rate derived by iteration from the post-tax rate is the correct value, and finds that grossing up is applicable only in those rare situations where future cash flows are constant. Like *Husmann*, *Schmidt* and *Seidel* (2002), therefore, *Kvaal* (2007) does not present a discount rate that fulfills all of IAS 36's requirements.

As with the theoretical debate, the opinions of the big four audit companies do not provide a satisfying result. All of the commentaries basically restate the two approaches given by IAS 36. While *Deloitte* (2013) section 8.3.1 states that, in practice, grossing up could be a reasonable approximation if a cash-generating unit is considered, *Ernst & Young* (2013) section 22.4.5.4 declares that grossing up will work only in very specific situations. *Ernst & Young* (2013) section 22.4.5.3 and *PwC* (2013) section 18.222.5 both elaborate extensively on how the pre-tax and post-tax cash flows must be determined to appropriately consider the influence of deferred taxes, but finally their arguments are based on the assumption that, without deferred taxes, the value in use before taxes equals that after taxes.

As we do not have a tax system that is neutral with regard to different investment alternatives the value in use before taxes does not equal that after taxes, independent of the existence of deferred taxes. Thus, neither the iterative approach nor grossing up will deliver suitable results, meaning the pre-tax rate should in fact be calculated directly.

4.3.3 Standard-CAPM and Tax-CAPMs

In section 4.3.1 we suggested that the cost of capital of the fictitiously unlevered firm is suitable to calculate a discount rate independent of the capital structure, and hence it should be used to calculate the value in use. The cost of equity of a firm is usually calculated using the CAPM. Therefore, in this section, we want to briefly describe why the CAPM is not suitable – at least not without further assumptions – to derive the discount rate for the calculation of the value in use. As this might seem intuitive, we additionally describe why the Tax-CAPMs cannot be applied.

The CAPM was developed in the 1960s by *Sharpe* (1964), *Lintner* (1965) and *Mossin* (1966). It is an equilibrium model that can be used to calculate the prices and returns of all risky assets traded on the capital market. Moreover, if the capital market is sufficiently complete, one can reasonably assume that the cash flows of non-traded assets can be replicated by traded assets.[15] The price of the non-traded asset equals the price of the portfolio used to replicate its cash flows to prevent arbitrage. One assumption underlying the CAPM is that there are neither taxes nor transaction costs. However, applied in a world with taxes, the prices and returns calculated are post-tax prices or returns. As a rational investor decides on the basis of observable data, and because observable data is after taxes on the firm level and before taxes on the private level, prices and returns calculated with the CAPM will therefore be after taxes on the firm level and before taxes on the private level.

The classical Tax-CAPM was originally developed by *Brennan* (1970) but has been

[15] This assumption, called "spanning", is quite usual in finance theory. For the necessary conditions, see, for example, *Duffie* and *Huang* (1985).

repeatedly developed further to meet the special conditions of national tax systems.[16] These Tax-CAPMs incorporate the fact that a rational investor will not only include observable data in his decisional calculus, but will also consider future tax payments on the private level. Applied in the real world, these models give the return after taxes on the firm level as well as on the private level, with only the latter being explicitly modeled.

As outlined above in section 4.2, we assume that for the calculation of the value in use a discount rate before taxes on both the firm and the private level is required. This requirement is neither met by the classical CAPM nor by the Tax-CAPMs – or indeed by any other model we know of. The existence of this research gap is not too surprising if one considers that the exclusion of taxes gives no further insights from the perspective of a finance theoretician. Still, as IAS 36 requires the calculation of a discount rate before taxes on both the firm and the private level, we will now present an approach to modify the CAPM according to the requirements of IAS 36.

4.4 A Pre-Tax CAPM

We have outlined in section 4.3 that we understand the rules of IAS 36 to be the requirement to calculate a discount rate that is independent of the capital structure, and that this is a pre-tax rate with respect to taxes on the firm as well as on the private level. In this section we derive a model that is theoretically suited to calculating a pre-tax discount rate. In section 4.4.2 we briefly discuss why a further adjustment to eliminate influences of the capital structure is not necessary. Our model is basically a variation of the CAPM with the additional assumption that there are taxes on the firm level. The cash flows that are related to these taxes, as well as the pre-tax cash flows,

[16]For Germany, see, for example, *Wiese* (2006), *Wiese* (2007) and *Jonas*, *Löffler* and *Wiese* (2004).

are not traded on the market but are spanned. For the sake of readability, however, we will still talk about the prices and cash flows of these assets and not about the prices and cash flows of the portfolios used to span them. Because the market is arbitrage-free the sum of the prices for the pre-tax cash flows and for the tax cash flows has to equal the price of the cash flows after taxes on the firm level. We do not have to adjust for taxes on the private level, as these are excluded from the CAPM anyway.

4.4.1 The Model

The traditional assumptions for the CAPM are valid. The only variation is the introduction of taxes on the firm level. For the derivation of the pre-tax discount rate we apply the derivation technique of *Kruschwitz* and *Husmann* (2012), originally developed by *Mossin* (1966). The following maximization problem has to be solved:

$$\max U^i\Big(C_0^i, E^i[\tilde{C}_1^i], Var^i[\tilde{C}_1^i]\Big) \tag{4.4.1}$$

s.t.

$$C_0^i + \frac{n_0^i}{1+r_f} + \sum_{j=1}^{J} n_j^i\Big(P(\tilde{X}_j) - P\big(T(\tilde{X}_j)\big)\Big) = \bar{C}_0^i + \frac{\bar{n}_0^i}{1+r_f} + \sum_{j=1}^{J} \bar{n}_j^i\Big(P(\tilde{X}_j) - P\big(T(\tilde{X}_j)\big)\Big)$$

$$C_{1s}^i = n_0^i + \sum_{j=1}^{J} n_j^i\big(X_{js} - T(X_{js})\big).$$

The first constraint depicts investor i's budget constraint. The investor tries to maximize his utility U^i, which is determined by today's consumption C_0^i and the expected consumption tomorrow $E^i[\tilde{C}_1^i]$ as well as its variance $Var^i[\tilde{C}_1^i]$. n_j^i reflects the amount of security j held by investor i in $t = 0$. From security j the investor receives an uncertain cash flow in the amount of $\tilde{X}_j - T(\tilde{X}_j)$ in $t = 1$. In contrast to the CAPM, this cash flow is split into two components: the uncertain cash flow before taxes on the firm level $\tilde{X}_j$ and the uncertain tax cash flow $T(\tilde{X}_j)$. The difference between these two components equals the post-tax cash flow considered in the CAPM. $P(\tilde{X}_j)$ reflects the price of the uncertain cash flow before taxes in $t = 0$, the price of the uncertain tax cash flow is given by $P\big(T(\tilde{X}_j)\big)$. Hence, like the cash flow, the price is split into two components. n_0^i is the amount of the risk-free asset contained in the portfolio of investor i. For calculational simplicity, we set the price of this risk-free asset in $t = 0$ to $\frac{1}{1+r_f}$, resulting in a certain cash flow in $t = 1$ in the amount of 1 due to a return in the amount of r_f. A bar on top of a variable indicates the initial endowment in $t = 0$.

The second constraint describes the state-dependent consumption of investor i in $t = 1$, C_{1s}^i. In addition to the certain cash flow from the risk-free asset n_0^i, investor i receives the state-dependent cash flows before taxes X_{js} less the state-dependent tax cash flows $T\big(X_{js}\big)$ in state s.

For the expected value and the variance of the future consumption of investor i, $\tilde{C}_1^i$, with

$$\tilde{C}_1^i = n_0^i + \sum_{j=1}^{J} n_j^i \big(\tilde{X}_j - T(\tilde{X}_j)\big)$$

the following relations apply:[17]

[17]In contrast to the CAPM, where, with the given notation, the variance of the future state-dependent consumption of investor i amounts to $Var^i[\tilde{C}_{1,\text{classic CAPM}}^i] = \sum_{j=1}^{J} \sum_{k=1}^{J} n_j^i n_k^i Cov^i[\tilde{X}_j, \tilde{X}_k]$, we receive additional covariances due to the consideration of the uncertain tax cash flows. This result follows from the calculation rule for variances of linear combinations of stochastic variables $Var[\sum_{i=1}^{n} a_i \tilde{X}_i] = \sum_{i=1}^{n} \sum_{j=1}^{n} a_i a_j Cov[\tilde{X}_i, \tilde{X}_j]$.

$$
\begin{aligned}
E^i[\tilde{C}_1^i] &= n_0^i + \sum_{j=1}^{J} n_j^i \big(E^i[\tilde{X}_j] - E^i[T(\tilde{X}_j)]\big) \\
Var^i[\tilde{C}_1^i] &= \sum_{j=1}^{J}\sum_{k=1}^{J} n_j^i n_k^i \Big(Cov^i[\tilde{X}_j, \tilde{X}_k] - Cov^i[\tilde{X}_j, T(\tilde{X}_k)] \\
&\qquad -Cov^i[T(\tilde{X}_j), \tilde{X}_k] + Cov^i[T(\tilde{X}_j), T(\tilde{X}_k)]\Big) .
\end{aligned}
$$

By substituting the expected value and the variance in the utility function we can reduce the maximization problem 4.4.1 and state the Lagrangian function with only one constraint:

$$
\begin{aligned}
\mathcal{L} = U^i&\Big(C_0^i, E^i[\tilde{C}_1^i], Var^i[\tilde{C}_1^i]\Big) \\
&+ \kappa \left(C_0^i + \frac{n_0^i}{1+r_f} + \sum_{j=1}^{J} n_j^i \Big(P(\tilde{X}_j) - P\big(T(\tilde{X}_j)\big)\Big) \right. \\
&\left. - \bar{C}_0^i - \frac{\bar{n}_0^i}{1+r_f} - \sum_{j=1}^{J} \bar{n}_j^i \Big(P(\tilde{X}_j) - P\big(T(\tilde{X}_j)\big)\Big) \right) .
\end{aligned}
$$

We can then derive the individual demand function by calculating the first-order conditions and differentiating with respect to n_0^i and n_j^i:

$$
\begin{aligned}
P(\tilde{X}_j) = {} & \frac{E^i[\tilde{X}_j] - E^i[T(\tilde{X}_j)]}{1+r_f} \\
& - h^i \sum_{k=1}^{J} n_k^i \left(\frac{Cov^i[\tilde{X}_j, \tilde{X}_k] - Cov^i[\tilde{X}_j, T(\tilde{X}_k)]}{1+r_f} \right. \\
& \left. - \frac{Cov^i[T(\tilde{X}_j), \tilde{X}_k] - Cov^i[T(\tilde{X}_j), T(\tilde{X}_k)]}{1+r_f} \right) + P\big(T(\tilde{X}_j)\big),
\end{aligned}
$$

where the following is true for the utility-term of investor i, h^i:

$$
h^i := -2 \frac{\partial U^i / \partial Var^i[\tilde{C}_1^i]}{\partial U^i / \partial E[\tilde{C}_1^i]}.
$$

Considering

$$
\sum_{i=1}^{I} \frac{1}{h^i} = \frac{1}{H}, \quad \sum_{i=1}^{I} \sum_{k=1}^{J} n_k^i \tilde{X}_k = \tilde{X}_m \quad \text{and} \quad \sum_{i=1}^{I} \sum_{k=1}^{J} n_k^i T(\tilde{X}_k) = T(\tilde{X}_m)
$$

and aggregating for all market participants gives the aggregated indirect demand function, where $\tilde{X}_m$ represents the uncertain cash flows from the market portfolio before taxes and $T(\tilde{X}_m)$ represents the uncertain tax cash flows of the market portfolio:

$$
\begin{aligned}
P(\tilde{X}_j) = {} & \frac{E[\tilde{X}_j] - E\big[T(\tilde{X}_j)\big]}{1+r_f} \\
& - H\left(\frac{Cov[\tilde{X}_j, \tilde{X}_m] - Cov\big[\tilde{X}_j, T(\tilde{X}_m)\big]}{1+r_f}\right. \\
& - \left.\frac{Cov\big[T(\tilde{X}_j), \tilde{X}_m\big] - Cov\big[T(\tilde{X}_j), T(\tilde{X}_m)\big]}{1+r_f}\right) + P\big(T(\tilde{X}_j)\big).
\end{aligned} \tag{4.4.2}
$$

By solving 4.4.2 for H, multiplying by n_j^i and taking the sum over all market participants and securities, we can eliminate the utility-term H. Using

$$
\sum_{i=1}^{I}\sum_{j=1}^{J} n_j^i \tilde{X}_j = \tilde{X}_m \quad \text{and} \quad \sum_{i=1}^{I}\sum_{j=1}^{J} n_j^i T(\tilde{X}_j) = T(\tilde{X}_m)
$$

delivers for H

$$
H = \frac{E[\tilde{X}_m] - E\big[T(\tilde{X}_m)\big] - (1+r_f)\Big(P(\tilde{X}_m) - P\big(T(\tilde{X}_m)\big)\Big)}{Var[\tilde{X}_m] - 2Cov\big[\tilde{X}_m, T(\tilde{X}_m)\big] + Var\big[T(\tilde{X}_m)\big]}.
$$

Inserting this relation into equation 4.4.2 thus gives the price equation of our model:

$$P(\tilde{X}_j) = \frac{E[\tilde{X}_j] - E\big[T(\tilde{X}_j)\big] - \frac{E[\tilde{X}_m] - E\left[T(\tilde{X}_m)\right] - (1+r_f)\left(P(\tilde{X}_m) - P\left(T(\tilde{X}_m)\right)\right)}{Var[\tilde{X}_m] - 2Cov\left[\tilde{X}_m, T(\tilde{X}_m)\right] + Var\left[T(\tilde{X}_m)\right]} \cdot Cov_{j,m}}{1 + r_f} \tag{4.4.3}$$

$$+ P\big(T(\tilde{X}_j)\big),$$

with

$$Cov_{j,m} = Cov[\tilde{X}_j, \tilde{X}_m] - Cov\big[\tilde{X}_j, T(\tilde{X}_m)\big] - Cov\big[T(\tilde{X}_j), \tilde{X}_m\big] + Cov\big[T(\tilde{X}_j), T(\tilde{X}_m)\big].$$

For our purposes, we need to consider the two different components of the cash flows only for security j. Using $E[\tilde{X}'_m] = E[\tilde{X}_m] - E\big[T(\tilde{X}_m)\big]$ und $P(\tilde{X}'_m) = P(\tilde{X}_m) - P\big(T(\tilde{X}_m)\big)$ we can simplify equation 4.4.3:

$$P(\tilde{X}_j) = \frac{E[\tilde{X}_j] - E\big[T(\tilde{X}_j)\big] - \frac{E[\tilde{X}'_m] - (1+r_f)P(\tilde{X}'_m)}{Var[\tilde{X}'_m]} \cdot Cov_{j,m'}}{1 + r_f} + P\big(T(\tilde{X}_j)\big) \tag{4.4.4}$$

with $\quad Cov_{j,m'} = Cov[\tilde{X}_j, \tilde{X}'_m] - Cov\big[T(\tilde{X}_j), \tilde{X}'_m\big].$

Here, $E[\tilde{X}'_m]$ and $P(\tilde{X}'_m)$ reflect the expected cash flow and the price of the market portfolio used in the CAPM, respectively.

For the return of the market portfolio after taxes $\tilde{r}'_m$, the pre-tax return of security j, $\tilde{r}_j$, and for the tax return of security j, $\tilde{\tau}_j$, the following relations hold:

$$\tilde{r}'_m = \frac{\tilde{X}'_m}{P(\tilde{X}'_m)} - 1, \quad \tilde{r}_j = \frac{\tilde{X}_j}{P(\tilde{X}_j)} - 1 \quad \text{and} \quad \tilde{\tau}_j = \frac{T(\tilde{X}_j)}{P\big(T(\tilde{X}_j)\big)} - 1.$$

Considering the calculation rules of variances and covariances, inserting $E[\tilde{X}'_m] =$

$(1 + E[\tilde{r}'_m])P(\tilde{X}'_m)$, $E[\tilde{X}_j] = (1 + E[\tilde{r}_j])P(\tilde{X}_j)$ and $E\big[T(\tilde{X}_j)\big] = (1 + E[\tilde{\tau}_j])P\big(T(\tilde{X}_j)\big)$ in equation 4.4.4 gives:

$$P(\tilde{X}_j) = \frac{(1 + E[\tilde{r}_j])P(\tilde{X}_j) - (1 + E[\tilde{\tau}_j])P\big(T(\tilde{X}_j)\big) - \frac{(1+E[\tilde{r}'_m])P(\tilde{X}'_m)-(1+r_f)P(\tilde{X}'_m)}{P(\tilde{X}'_m)^2 Var[\tilde{r}'_m]} \cdot Cov_{j,m'}}{1 + r_f} + P\big(T(\tilde{X}_j)\big)$$

with $\quad Cov_{j,m'} = P(\tilde{X}_j)P(\tilde{X}'_m)Cov\big[\tilde{r}_j, \tilde{r}'_m\big] - P\big(T(\tilde{X}_j)\big)P(\tilde{X}'_m)Cov\big[\tilde{\tau}_j, \tilde{r}'_m\big]$.

We can cancel $P(\tilde{X}'_m)$ in the variance-covariance term, resulting in:

$$P(\tilde{X}_j) = \frac{(1 + E[\tilde{r}_j])P(\tilde{X}_j) - (1 + E[\tilde{\tau}_j])P\big(T(\tilde{X}_j)\big) - \frac{E[\tilde{r}'_m]-r_f}{Var[\tilde{r}'_m]} \cdot Cov'_{j,m'}}{1 + r_f} + P\big(T(\tilde{X}_j)\big) \tag{4.4.5}$$

with $\quad Cov'_{j,m'} = P(\tilde{X}_j)Cov\big[\tilde{r}_j, \tilde{r}'_m\big] - P\big(T(\tilde{X}_j)\big)Cov\big[\tilde{\tau}_j, \tilde{r}'_m\big]$.

We solve this expression for $(1 + r_f)$ and divide by $P(\tilde{X}_j)$. Therefore, we first have to define the rate of exchange of the prices of the cash flow before taxes and the tax cash flow of security j as $\alpha = \frac{P\left(T(\tilde{X}_j)\right)}{P(\tilde{X}_j)}$. This results in the following:

$$1 + r_f = 1 + E[\tilde{r}_j] - \alpha(1 + E[\tilde{\tau}_j]) - \frac{E[\tilde{r}'_m] - r_f}{Var[\tilde{r}'_m]} \cdot \big(Cov\big[\tilde{r}_j, \tilde{r}'_m\big] - \alpha Cov\big[\tilde{\tau}_j, \tilde{r}'_m\big]\big) + \alpha(1 + r_f).$$

After some final transformations we receive the return equation of our model:

$$E[\tilde{r}_j] = r_f(1-\alpha) + \alpha E[\tilde{\tau}_j] + \frac{E[\tilde{r}'_m] - r_f}{Var[\tilde{r}'_m]} \cdot \left(Cov\left[\tilde{r}_j, \tilde{r}'_m\right] - \alpha Cov\left[\tilde{\tau}_j, \tilde{r}'_m\right]\right). \quad (4.4.6)$$

In the CAPM, the beta factor is defined as $\beta' = \frac{Cov\left[\tilde{r}'_j, \tilde{r}'_m\right]}{var\left[\tilde{r}'_m\right]}$. Similarly, we define

$$\beta = \frac{Cov\left[\tilde{r}_j, \tilde{r}'_m\right]}{Var[\tilde{r}'_m]} \quad \text{and} \quad \beta^\tau = \frac{Cov\left[\tilde{\tau}_j, \tilde{r}'_m\right]}{Var[\tilde{r}'_m]}$$

and thus rewrite equation 4.4.6 as follows:[18]

$$E[\tilde{r}_j] = r_f(1-\alpha) + \alpha E[\tilde{\tau}_j] + (E[\tilde{r}'_m] - r_f)(\beta - \alpha\beta^\tau). \quad (4.4.7)$$

It should be noted that, even though it looks quite similar, there are some important differences between equation 4.4.7 and the return equation of the classical CAPM that require consideration. For the risk-free interest rate r_f and the expected return of the market portfolio $E[\tilde{r}'_m]$, standardized methods of evaluation have evolved, which we will not discuss further here. However, in α and $E[\tilde{\tau}_j]$, this model introduces two additional firm-specific factors that have to be calculated before the pre-tax discount rate can be determined. Additionally, the beta factor is split into two components β and β^τ that have to be estimated separately.

Alpha α represents the rate of exchange of the prices of the cash flow before taxes and the tax cash flow. There are some simple relations regarding α that we can

[18]Under the assumption of a linear relation between $\tilde{X}_j$ and $T(\tilde{X}_j)$, equation 4.4.7 is reduced to the return equation of the classical CAPM. Such a linear relation represents one specific tax system that is neutral with regard to different investment alternatives: the taxation of cash flows.

analyze. First, if the expected pre-tax cash flow and the expected tax cash flow are positive, the prices will be positive as well, resulting in a positive value for α. Similarly, if the expected pre-tax cash flow and the expected tax cash flow are negative, the prices will be negative as well, resulting again in a positive value for α. However, a negative value for α could result from the fact that the net profit is used as the tax base, and hence there are situations in which the pre-tax cash flow is positive and the tax cash flow is negative. Thus, we expect α to be usually positive but there can be exceptions. Second, if the relation of $\tilde{X}_j$ and $T(\tilde{X}_j)$ was linear, then α would represent the tax rate. Even if there is no linear relation, i.e. if the cash flow is not used as the tax base, usually $|T(\tilde{X}_j)| < |\tilde{X}_j|$ will be valid. Again, due to the fact that the profit is used as the tax base, there can be exceptions. However, as long as $|E\big[T(\tilde{X}_j)\big]| < |E[\tilde{X}_j]|$ is true, $|P\big(T(\tilde{X}_j)\big)| < |P(\tilde{X}_j)|$ is necessary to prevent arbitrage, resulting in $\alpha < 1$. Therefore, taken together α should usually be positive and smaller than 1.

To calculate α, the prices of the pre-tax cash flow and the tax cash flow have to be determined. Looking at equation 4.4.5, we see that we therefore need to determine the expected pre-tax cash flow, the expected tax cash flow and the covariances of the cash flow from the market portfolio with the two components of the firm-specific cash flow. The calculation of the expected pre-tax cash flow and the expected tax cash flow might entail some difficulties, but these calculations are possible based on corporate planning. In contrast, neither the expected cash flow of the market portfolio, nor its variance or the respective price are known. The same is true for the covariance of the post-tax cash flow of the market portfolio and the pre-tax cash flow or the tax cash flow of the individual security. While it may be possible to estimate the expected cash flow of the market portfolio, its variance and the price of the market portfolio from historical data, the calculation of the required covariances will confront practitioners with material problems as none of the values are observable.

Tax return $E[\tilde{\tau}_j]$ represents the expected tax return, given by $E\big[T(\tilde{X}_j)\big] = (1 + E[\tilde{\tau}_j])P\big(T(\tilde{X}_j)\big)$. In our return equation, $E[\tilde{\tau}_j]$ is an addition to the pre-tax return due to the uncertainty regarding future tax payments. If taxes were certain, $E[\tilde{\tau}_j] = r_f$ would be true. However, as the variance-covariance risk increases, the price for the tax cash flows decreases, which in turn increases $E[\tilde{\tau}_j]$.

For the calculation of $E[\tilde{\tau}_j]$, the expected tax cash flow as well as its price is required. As already discussed for α, the calculation of $P\big(T(\tilde{X}_j)\big)$ is especially problematic.

Beta factors In the model presented in this section, the beta factor is split into two components: the covariance risk of the market portfolio with the pre-tax return, and the tax return. Here, one has to remember that β reflects the covariance of the pre-tax return with the post-tax return of the market portfolio, and hence it is not equal to the beta factor used in the classical CAPM, which reflects the covariance risk of the post-tax return with the post-tax return of the market portfolio.

For the calculation of the cost of capital using the classical CAPM, the beta factor is calculated based on observed market data. Here, neither the factors necessary to calculate β nor those necessary to calculate β^{τ} are observable. Therefore, it is not clear how the beta factors could be estimated.

One appealing feature of the CAPM, and probably the reason for its widespread use in practice, is that only the expected return of the market portfolio and its variance as well as the covariance of the return of the market portfolio with the return of the individual security are required as input factors. All these factors can reasonably be estimated from historical data. This does not hold true for the parameters required to calculate the pre-tax discount rate. In practice the application of the model presented here would therefore require extensive research for the calculation of the parameters required.

4.4.2 Leverage Risk

In section 4.4.1 we showed how a discount rate before income taxes on the private as well as the firm level can theoretically be determined. In section 4.3 we identified the independence of the capital structure as the second requirement of IAS 36 regarding the discount rate used to calculate the value in use. We additionally argued that the cost of equity of the fictitiously unlevered firm can be used to fulfill this requirement. In this section, we want to discuss the question of whether and how the pre-tax cost of equity from equation 4.4.7 have to be transformed to reflect the pre-tax cost of equity of the fictitiously unlevered firm.

To calculate the cost of equity of a fictitiously unlevered firm in a post-tax setting, the cost of equity of the levered firm – determined using the CAPM – is transformed using the Miles-Ezzell formula or the Modigliani-Miller formula. The transformation is necessary due to the existence of the tax shield. The cash flows of the levered firm exceed those of the unlevered firm because the interest payments are tax deductible and hence they reduce the tax payments. If the lower cash flows of the fictitiously unlevered firm are discounted, the discount rate has to be transformed to incorporate this fact. This transformation is usually called *unlevering*.

IAS 36 requires the calculation of the value in use on a pre-tax basis. Hence, the present value of the future pre-tax cash flows $\tilde{X}_j$ has to be determined. However, if the cash flows of a levered firm differ from those of an unlevered firm only by the tax cash flows (which are lower for the levered firm), then the pre-tax cash flows of a levered firm and those of an unlevered firm have to be identical. The tax shield thus has to be contained in $T(\tilde{X}_j)$. From this, it follows that a transformation of the cost of equity is superfluous in the pre-tax setting. Rather, to fulfill all the requirements of IAS 36, it would be suitable to calculate the pre-tax discount rate according to equation 4.4.7.

We want to emphasize that this does not mean that we operate in a world without taxes, in which the capital structure has no influence on the value in use. Rather, we work in a world with taxes and therefore we have derived a formula for the calculation of a pre-tax discount rate in section 4.4.1. The fact that *unlevering* is not necessary is due to the requirement of IAS 36.50 to consider only the pre-tax cash flows – which are not influenced by the capital structure.

4.5 Summary and Conclusion

In this study we analyze the requirements of IAS 36 regarding the discount rate that has to be used to calculate the value in use. Despite the fact that the rules of IAS 36 contain several requirements that are theoretically interesting and confront the practice with unsolved problems, theoretical discussion is scarce. We identified two requirements that are most appealing: the independence of the capital structure and the requirement to use a pre-tax rate.

IAS 36 requires the use of a discount rate that is independent of the capital structure and, at the same time, presents the WACC as a suitable starting point for the derivation. *Modigliani* and *Miller* (1958) proved that in a world without taxes, the WACC as well as the market value of the firm are independent of the capital structure. However, as we are not in a world without taxes, the use of WACC does not fulfill the requirement of a discount rate that is independent of the capital structure. Rather, the cost of equity of a fictitiously unlevered firm should be used, as this is not influenced by the capital structure. We do not see a conflict with the specifications of IAS 36, as independence of the capital structure is an explicit requirement while the WACC is only given as one potential starting point.

Regarding the calculation of a pre-tax discount rate, IAS 36 argues that the value in use calculated by discounting the post-tax cash flows with a post-tax discount rate should usually equal the value in use calculated by discounting the pre-tax cash flows with a pre-tax discount rate. From this it follows that the pre-tax discount rate can be iteratively determined from the post-tax rate. In fact, such a relation exists only if a special tax system applies, i.e. one that is neutral with regard to different investment alternatives. This is not the case in any European country. Hence, the pre-tax rate cannot be derived from the post-tax rate. We interpret IAS 36 as entailing the requirement to use a discount rate that is not influenced by income taxes, either on the private or the firm level. The result of the classical CAPM as well as of the Tax-CAPMs are discount rates after taxes on the firm level. We derive a variation of the CAPM that is theoretically suited to the calculation of a discount rate before income taxes on both levels.

As only the cash flows before taxes have to be considered in the calculation of the value in use, *unlevering* is not necessary. Nevertheless, the practical use of the model derived in this study is questionable. While it is theoretically suited to fulfill all the requirements of IAS 36, the derivation of all parameters necessary to calculate the pre-tax rate will necessitate material further research. Additionally, as several previous authors have argued, the pre-tax calculation contradicts the intention of the IASB to construct an impairment test that reflects the decisional calculus of the rational investor. Combined with the imponderables related to the practical implementation of the model derived here, this fact leads to our recommendation to the IASB to revise the rules concerning the calculation of the value in use. A post-tax calculation would reduce managerial discretion as well as problems in the practical application.

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5 A New Perspective on Fixed Asset Write-Offs – When is Earnings Management Optimal

Chapter contents

A New Perspective on Fixed Asset Write-Offs – When is Earnings Management Optimal

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Abstract We analyze under which situations it is optimal to opportunistically delay a fixed asset write-off and when transparent reporting of write-offs is optimal. We apply a simplified real options approach to find an answer to this question. Therefore, we analyze two settings, one of which does not allow for reporting discretion while the other one does. If there is no reporting discretion the expected carrying amount can be reflected by reducing the carrying amount after depreciation by the payoff of a put option, with the carrying amount as the strike price and the recoverable amount as the underlying. If reporting discretion exists regarding the reporting of write-offs, the payoff the firm earns when the write-off is delayed can be interpreted as the value of a barrier option with the carrying amount as the barrier and the recoverable amount as the underlying. We find that the probability that write-offs are delayed increases with the benefits of earnings management and decreases with the costs of earnings management and the benefits of transparent reporting.

5.1 Introduction

In 2011 the Vodafone Group Plc recorded a write-off in the amount of EUR 6.2 bn, which corresponded to about 4 % of their prior year total assets.[1] At the same time, there is a current and widespread discussion about the fact that write-offs are understated and delayed.[2] Due to their magnitude and the possibility of material influences on the stock price, write-offs have been a focus for researchers ever since. Under *International Financial Reporting Standards* (IFRS), write-offs have to be recognized whenever the recoverable amount of the asset under consideration falls below its carrying amount. Hence, write-offs correct for declines in the recoverable amount exceeding systematic depreciations. In the existing research asset write-offs are often linked to earnings management. However, to the best of our knowledge the circumstances under which managers decide to apply earnings management in the write-off decision have not been analyzed until now. In this study we examine the write-off decision using a simplified real options approach, which enables us to identify the circumstances under which it is optimal to apply earnings management. Our findings should be of interest to market participants, international standard setting boards and enforcement institutions, since they can be used as the basis for a strategy to decrease the use of earnings management in the write-off of fixed assets.

Earnings management is usually defined as the attempt to manage reported earnings to receive a specific goal.[3] Similarly, for the purposes of this paper, we define earnings

[1]See *Vodafone Group Plc* (2011), pp.80–81.

[2]In his speech at the IAAER conference in Amsterdam 2012, the chairman of the *International Accounting Standards Board* (IASB) Hans Hoogervorst stated that the impairment test often comes too late; see *Hoogervorst* (2012). Similarly, a recent survey by the *European Securities and Markets Authority* (ESMA) found that goodwill write-offs do not seem to reflect the effects of the financial and economic crises appropriately; see *ESMA* (2013)

[3]See, for example, *Fields*, *Lys* and *Vincent* (2001) and *Healy* and *Wahlen* (1999).

management as follows:

> "Earnings management occurs whenever a firm reports numbers that deviate from the best estimate."

It is important to recognize that this definition does not necessitate information asymmetries. Even though a firm will not engage in earnings management without expecting benefits, it will suffice if not all market participants are willing to undo the effects of earnings management.[4] Still, for the possibility of earnings management to arise a necessary condition is that there must be room for judgment. Regarding asset write-offs, it is usually argued that managerial discretion arises either because of missing accounting rules or because existing accounting rules refer to unobservable measures.[5] In this paper we analyze write-offs in the special setting of IFRS.[6] IAS 36 *Impairment of Assets* gives specific instructions regarding the timing and valuation of fixed asset write-offs. Managerial discretion therefore arises from the lack of observability of the employed accounting measures. We argue that even though there are no information asymmetries, managerial discretion in the preparation of financial statements exists regarding the reporting of write-offs.

In the existing research, there is an ongoing debate on the so-called depreciation problem. *Jackson* (1911) described this problem as the necessity to accumulate reserves during the useful life of a fixed asset so as to be able to replace it at the end of its useful life. In more recent research, the accounting and the economic approach to the depreciation problem have been distinguished. While the accounting approach requires the distribution of the depreciation amount over the useful life in a systematic

[4] See *Fields*, *Lys* and *Vincent* (2001).
[5] See, for example, *Zucca* and *Campbell* (1992), *Riedl* (2004).
[6] Due to the general setting of the model applied our findings are equally valid for the write-off decision under similar accounting rules such as US GAAP.

and rational manner to match income and expenses for each asset, the aim of the economic approach is to reflect the "true" depreciation.[7] The rationale behind the economic approach to the depreciation problem is that, from a financial management perspective, the depreciations should provide useful information for optimal investment decision making. The accounting depreciation usually does not fulfill this requirement.[8] From the accounting approach, research concerning the optimal depreciation choice to minimize taxes evolved.[9] For the analysis at hand we assume the depreciation method to be externally given. Hence, we do not provide further insights into the depreciation problem analyzing the write-off decision under fixed depreciations.

Goex and *Wagenhofer* (2009) use a game theoretical approach to show that conservative accounting – which they identify by the recognition of write-offs in contrast to revaluations – is the optimal accounting system if lenders have to construct debt contracts based on the accounting information. We do not consider debt contracts, instead analyzing the decision to immediately recognize write-offs or to delay them opportunistically given specific payoffs for earnings management.

Empirical studies on asset write-offs focus on two main issues. First, they analyze which determinants influence the decision to write off and the amount that is written off and second, they look into the capital market's reaction to the recorded write-offs. The approach of those studies that analyze the determinants of fixed asset write-offs is to define situations in which earnings management is expected to arise (e.g. years in which the management changed or years in which the company is in danger of breaching covenants from credit agreements) and thus to analyze whether write-offs are recognized

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[7]See, for example, *Wright* (1964).
[8]See, for example, *Kim* and *Moore* (1988) and *Eichin* and *Schneeweiss* (2001).
[9]See, for example, *Landskroner* and *Levy* (1979), *Berg*, *Waegenaere* and *Wielhouwer* (2001) and *Kulp* and *Hartman* (2011).

more often or are of a higher magnitude in these periods. Early empirical studies from *Elliott* and *Shaw* (1988), *Zucca* and *Campbell* (1992) and *Cotter*, *Stokes* and *Wyatt* (1998) show that write-offs are regularly recognized in periods that coincide with managerial incentives. However, more recent studies from *Francis*, *Hanna* and *Vincent* (1996), *Riedl* (2004) and *Beatty* and *Weber* (2006) show that it is not only earnings management but also declines in asset values that are related to write-offs, which raises the question of when write-offs are driven by asset impairment and when it is earnings management that motivates the write-off. Recent studies from *Minnick* (2011) and *AbuGhazaleh*, *Al-Hares* and *Roberts* (2011) include corporate governance in their estimations and find that better governed companies are less likely to apply earnings management in the write-off decision, presumably because they have a lower expected use of earnings management. Concerning the capital market reaction, differing results have been found. *Elliott* and *Hanna* (1996) and *Francis*, *Hanna* and *Vincent* (1996) find a significant negative capital market reaction to write-offs. However, *Elliott* and *Shaw* (1988) and *Alciatore*, *Easton* and *Spear* (2000) show that the decrease in stock prices precedes the write-off, indicating that the capital market participants anticipate the loss. Finally, *Minnick* (2011) shows that the market reacts positively to write-offs that reflect asset impairment (which we will term transparent write-offs from now on), while negative abnormal returns follow opportunistic write-offs. Similar results have been found by *Keung*, *Lin* and *Shih* (2010), who show that the capital market punishes earnings management. The finding that capital market participants anticipate write-offs and see through earnings management supports our assumption that there are no information asymmetries.

While empirical studies have shown that earnings management is an important determinant of fixed asset write-offs, they cannot give a definitive answer to the question of when a firm chooses to apply earnings management. We argue that if managerial discretion exists regarding the recognition of write-offs the firm has the option to delay the write-off. We interpret this option as a real option and thus apply a simplified real options approach. The intention of this paper is to analyze under which circumstances transparent write-offs are a firm's optimal choice and when it is optimal to opportunistically delay write-offs.

Since the seminal works of *Majd* and *Pindyck* (1987) and *McDonald* and *Siegel* (1986) real options have played an important part in decision analysis and have frequently been applied in investment decision theory. A recent application is that by *Mölls* and *Schild* (2012). For the analysis in this paper we apply the technique to solve one important accounting problem and hence gather some valuable insights into certain key questions in accounting research.

We analyze two different settings. In the first setting, there is no discretion; if the asset is impaired a write-off is immediately recognized. We show that even in this simple setting the consideration of the potential write-off in future periods has a material effect on the expected carrying amount. More specifically, we show that the reduction of the carrying amount due to the possible write-off can be interpreted as the payoff of a short put option. We derive a valuation formula which is straightforward under these preconditions.

In the second setting, we introduce discretion regarding the recognition of write-offs. In particular, we assume that if the asset is impaired the firm has the option to delay the write-off. We show that the value of delaying the write-off can be interpreted as a down-and-in call with the carrying amount in the next period as the barrier. We derive a valuation formula for this barrier option, which is different to a typical barrier option in several ways. We find that the value of delaying the write-off increases with the benefits and decreases with the costs related to this earnings management. Additionally, we show that the payoff for transparent reporting also increases the value of the option, which is probably the most surprising result. Sensitivity analyses for the determinants of the decision to delay the write-off are presented.

The paper is organized as follows. In the following section we present our basic assumptions. Section 5.3 derives the expected value of an asset if there is no possibility to manage earnings. In section 5.4, earnings management is introduced and the optimal decision of the firm in an earnings management setting is analyzed. Section 5.5 summarizes our findings and concludes.

5.2 General Assumptions

In this section we turn our attention to some assumptions which are necessary for developing a computational simple model for the problem outlined above. We consider a firm that publishes annual statements in accordance with IFRS every year. The time interval $[0, T]$ consists of N years, $0,\ 1,\ 2, ...,\ t,\ t+1,\ t+2, ...,\ t+N = T$, where each year can be partitioned in n periods of equal length. One period could thereby describe a quarter of a year, for example. In order to provide closed-form solutions we will focus on the discussion of two arbitrary points in time.

The firm makes an investment in an asset (factory, equipment etc.) with a volume of I_s in period s, with $s < t$. We assume an arbitrage-free capital market, and that all cash flows regarding the firm can be replicated by buying or selling traded assets.[10] These assumptions imply an important precondition for our analysis: the existence of a risk-neutral probability measure $\mathbb{Q}$, which is equivalent to the real or subjective probability measure. This probability measure is one of the main findings in asset pricing.[11] In simplified terms, asset pricing under the risk-neutral probability measure

[10]This assumption, called "spanning" is quite usual in finance theory. For the conditions necessary, see, for example, *Duffie* and *Huang* (1985).
[11]For an intensive treatment, see, for example, *Harrison* and *Kreps* (1979) or *Shreve* (2004).

is performed by adjusting the probabilities of all possible future states such that they incorporate investors' preferences. This enables us to determine the present value of any kind of asset by using the risk-free rate. In addition, we assume the risk-free rate r_f to stay constant.

The valuation of the asset for the purpose of financial reporting follows the IFRS. According to IAS 16 *Property, Plant and Equipment*,[12] the initial carrying amount CA_s of the asset equals the investment volume, $\mathrm{CA}_s = I_s$. Assuming that the firm applies the cost model for measurement after recognition, the carrying amount of the asset has to be decreased each period by a depreciation D and, if applicable, a write-off WO. Assuming that straight-line depreciation is used, the carrying amount has to be decreased by a constant depreciation each year until the carrying amount equals the expected residual value RV at the end of the useful life UL. The useful life of the investment is assumed to be $\mathrm{UL} = T - s$. For simplicity, but without loss of generality, the residual value is assumed to be zero, $\mathrm{RV} = 0$. This implies constant annual depreciations of $\mathrm{D} = \frac{I_s}{\mathrm{UL}}$.

According to the rules of IAS 36 an asset has to be tested for impairment annually. We assume that the test is performed at the end of the year. The asset is said to be impaired whenever the recoverable amount is below the carrying amount. The recoverable amount is defined to be the higher value of the fair value less costs to sell and the value in use.[13] This definition represents the decisional calculus of a rational investor to sell the asset if this brings higher returns than the internal use of the asset.

[12]Conceptually comparable regulations are valid for most intangible assets according to IAS 38 *Intangible Assets*.

[13]IAS 36 presents detailed rules for how to derive the fair value less costs to sell and the value in use. In short, the fair value less costs to sell shall reflect the market price of the asset, and the value in use is the present value of the future cash flows expected to be derived from the further internal use of the asset.

If the asset is impaired, a write-off has to be recognized and the carrying amount has to be decreased to the recoverable amount. Throughout our analysis we assume that no write-off has to be recognized before t. Hence, without considering write-offs the carrying amount evolves as follows:

$$\mathrm{CA}_t = CA_{t-1} - \frac{I_s}{T-s}. \tag{5.2.1}$$

According to equation 5.2.1, CA_t depends on deterministic variables only, and thus is deterministic itself.

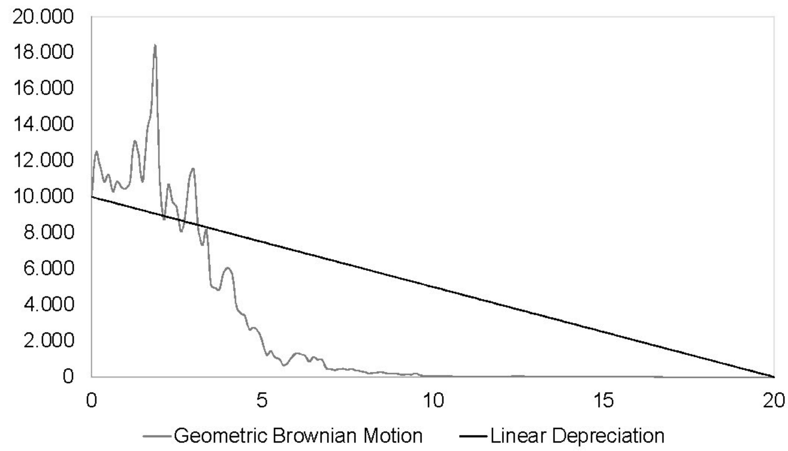
In contrast to the value of CA_t the value of RA_t is an uncertain quantity in $t-1$. A well-known assumption for modeling the future price (or market value) of an asset is the Geometric Brownian motion (GBM), originally used by *Merton* (1973b) and *Black* and *Scholes* (1973) to model the random behavior of stock prices. In the case of a single asset it is useful to directly model its market value.[14] Even though the recoverable amount does not reflect a single market value we assume for simplicity that the higher amount of a market-oriented value and the value in use follows a discrete approximation of a GBM.[15] Figure 5.1 depicts an exemplary pathway of the carrying amount without consideration of write-offs and the recoverable amount following a GBM with a drift of -0.05, which is equal to the depreciation rate applied to the carrying amount, and a variance of 0.2.

In order to provide a convenient and simple model we assume a recombining binomial lattice for the discrete approximation of the GBM as developed by *Cox*, *Ross* and

[14]See, for example, *Majd* and *Pindyck* (1987) and recently *Mölls* and *Schild* (2012). Furthermore, *Merton* (1973a) assumes that the market prices of all assets follow a GBM.

[15]A more detailed assumption could be that the fair value less costs to sell and the value in use follow two separate GBMs. In this case, the recoverable amount would follow a bivariate normal distribution. We believe that this approach, despite being more detailed, would give no further material insights into the questions we want to analyze.

Figure 5.1: Recoverable amount and carrying amount



Rubinstein (1979).[16] Due to the fact that accounting figures are published at specific time intervals (annually, semi-annually etc.) it is valid to perform a model analysis in discrete time. This approach is often used in real options or decision-tree analysis.[17]

As depicted in Figure 5.2, the recoverable amount RA_t at each node either increases by an upward-movement u with probability $p_{u,t}$ or decreases by a downward-movement d with probability $p_{d,t} = 1 - p_{u,t}$. This implies that the recoverable amounts of two subsequent periods t and $t+1$ have the following relationship:

$$\mathrm{RA}_{t+1} = \begin{cases} \mathrm{RA}_t \cdot u, & \text{in the case of an up-movement in } t+1, \\ \mathrm{RA}_t \cdot d, & \text{in the case of a down-movement in } t+1. \end{cases} \tag{5.2.2}$$

According to these preliminary considerations the expected recoverable amount can be calculated as follows:

[16]For a generalization see *Nelson* and *Ramaswamy* (1990).
[17]See, for example, *Brandao*, *Dyer* and *Hahn* (2005).

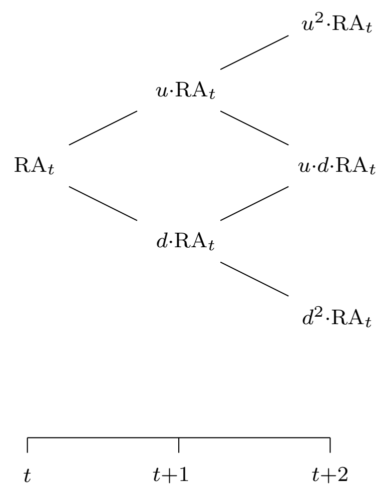
$$E_t\left[\mathrm{RA}_{t+1}\right] = p_{u,t}\cdot u\cdot \mathrm{RA}_t + p_{d,t}\cdot d\cdot \mathrm{RA}_t$$
$$= (p_{u,t}(u-d)+d)\mathrm{RA}_t. \tag{5.2.3}$$

The extended version of equation 5.2.3 for the consideration of N periods is given by:

$$E_0\left[\mathrm{RA}_T\right] = \sum_{j=1}^{N}\binom{N}{j} p_{u,t}^{k}\cdot p_{d,t}^{N-k}\cdot u^{k}\cdot d^{N-k}\cdot \mathrm{RA}_0, \tag{5.2.4}$$

where N is the number of periods and j is the number of up-movements.

Figure 5.2: A two-period binomial tree.

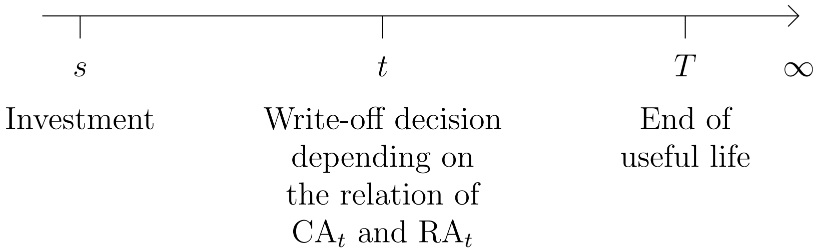


5.3 Immediate Write-Off: The Case without Earnings Management

5.3.1 Calculation of the expected Carrying Amount

Following the rules of IAS 36, an asset is said to be impaired when its recoverable amount RA_t falls below its carrying amount CA_t – hence if $\mathrm{RA}_t < \mathrm{CA}_t$. In this case, a write-off has to be recognized to reduce the carrying amount of the asset to the recoverable amount. The setting for this section is depicted by the timeline in Figure 5.3.

Figure 5.3: Timeline for immediate write-off



These preconditions imply that in an arbitrary period t, with $s < t$, the carrying amount of the asset after write-off, CA_t^*, can be determined by:

$$\begin{aligned} \mathrm{CA}_t^* &= \min(\mathrm{CA}_t; \mathrm{RA}_t) \\ \mathrm{CA}_t^* &= \mathrm{CA}_t - \max(0; \mathrm{CA}_t - \mathrm{RA}_t), \end{aligned} \tag{5.3.1}$$

where $-\max(0; \mathrm{CA}_t - \mathrm{RA}_t)$ states a payoff that is well known in option theory and can be interpreted as a short put option.

A put option is a (financial) contract that gives the holder (long position) the right to sell the underlying asset at the strike price at maturity to the writer (short position). (The holder of the put exercises the option at maturity when the current price of the underlying exceeds the strike price). In the described case, the holder of the put is the environment or the standard setter, the short position is held by the firm, the variable CA_t in the max-function can be interpreted as the strike price and the recoverable amount RA_t is the underlying asset. This implies that (under perfect conditions) the environment exercises the above stated put option as soon as $\mathrm{RA}_t < \mathrm{CA}_t$ and thereby enforces a write-off at the firm level that is equivalent to:

$$\mathrm{WO}_t = \mathrm{CA}_t - \mathrm{RA}_t. \tag{5.3.2}$$

As the recoverable amount is stochastic, the carrying amount after write-offs cannot be predicted with certainty. Nevertheless, the relation described by equation 5.3.1 enables us to calculate the expected future carrying amount as follows:

$$\begin{aligned} E[\mathrm{CA}_t^*] &= E[\mathrm{CA}_t - \max(0; \mathrm{CA}_t - \mathrm{RA}_t)] \\ E[\mathrm{CA}_t^*] &= \mathrm{CA}_t - E[\max(0; \mathrm{CA}_t - \mathrm{RA}_t)] \end{aligned} \tag{5.3.3}$$

Under the assumption that RA evolves according to equation 5.2.2 as depicted in Figure 5.2, the present value of the max-function reflecting the payoff of the put option can be calculated under the binomial probability distribution.

Following *Cox*, *Ross* and *Rubinstein* (1979), as a first step, the $\mathbb{Q}$-probabilities have to be determined based on u, d and r_f according to:

$$\begin{aligned} q_u &= \frac{1 + r_f - d}{u - d} \\ q_d &= \frac{u - (1 + r_f)}{u - d} \\ &\text{with } q_u + q_d = 1. \end{aligned} \tag{5.3.4}$$

As a second step, these $\mathbb{Q}$-probabilities have to be used to calculate the expected payoff of the put option in t under the risk-neutral probability measure by:

$$E_{\mathbb{Q}}[P_t] = \sum_{k=0}^{n} \binom{n}{k} q_u^k q_d^{n-k} \cdot \max(0; \mathrm{CA}_t - \mathrm{RA}_{t-1} \cdot u^k \cdot d^{n-k}). \tag{5.3.5}$$

Here, n is the number of subperiods and k is the number of up-movements. As $E_{\mathbb{Q}}[P_t]$ is the expected value under the risk-neutral probability measure, in the third step, r_f has to be applied to calculate the present value:

$$\mathrm{PV}(P_t) = E_{\mathbb{Q},t-1}[P_t] = \frac{E_{\mathbb{Q}}[P_t]}{1 + r_f}. \tag{5.3.6}$$

This present value under the risk-neutral probability measure equals the present value under the subjective probability measure. Now, to calculate the expected carrying amount in t considering a possible write-off in t we have to combine the findings of equations 5.2.1, 5.3.3, 5.3.5 and 5.3.6:

$$E_{\mathbb{P}}[\mathrm{CA}_t^*] = \mathrm{CA}_{t-1} - \frac{I_s}{T - s} - E_{\mathbb{Q},t-1}[P_t] \cdot (1 + r), \tag{5.3.7}$$

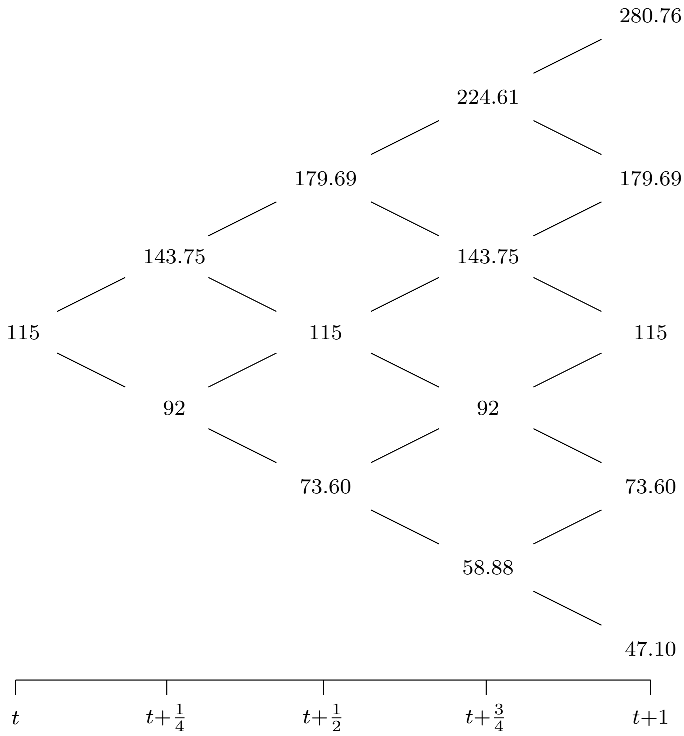
where r represents the risk-equivalent cost of capital.

5.3.2 Example without Earnings Management

In the example for the immediate write-off we consider a quarterly estimation of the recoverable amount and therefore assume that RA follows a five-step binomial lattice as depicted in Figure 5.4. The first step represents RA_t, the recoverable amount today, and the last step represents RA_{t+1}, the recoverable amount next year. This setting conforms to the assumption of the preparation of quarterly reports.

Using this binomial lattice and the equation given in 5.3.7 we are able to determine the expected book value of the asset considering a possible write-off in $t + 1$. To

Figure 5.4: Exemplary development of RA



apply the risk-neutral valuation method we first need to find the $\mathbb{Q}$-probabilities and the expected payoff in all possible states in $t+1$. The assumed parameters and the calculations are given in Table 5.1.

We see that the put option has a payoff that deviates from zero only for less than three up-movements, as only in these cases is the recoverable amount below the carrying amount in $t+1$. Nevertheless, the expected book value considering a possible write-off in $t+1$ amounts to 103, as opposed to the expected carrying amount without consideration of write-offs in equation 5.2.1, where it amounts to 120.

This finding could be of real interest to financial analysts, who try to predict earnings figures on the basis of the carrying amount of fixed assets deployed in the production

Table 5.1: Parameters and calculations: Example without earnings management

Assumed parameters:			
$u = 1.25$	$d = \frac{1}{u} = 0.8$	$r_f = 0.04$	$\mathrm{RA}_t = 115$
$I_s = 200$	$\mathrm{UL} = 10$	$\mathrm{CA}_t = 140$	$\Delta t = \frac{1}{4}$
$n = 4$	$r = 0.15$		
Development of the carrying amount:			
$\mathrm{CA}_{t+1} = 140 - \frac{200}{10} = 120$			
$\mathbb{Q}$-probabilities:			
$q_u = \frac{1+0.04-0.8}{1.25-0.8} = 0.53$		$q_d = \frac{1.25-(1+0.04)}{1.25-0.8} = 0.47$	
State-dependent values of the put option in $t+1$:			
$P_{uuuu} = \max[120 - 285.61; 0] = 0$		$P_{uuud} = \max[120 - 197.73; 0] = 0$	
$P_{uudd} = \max[120 - 136.89; 0] = 20$		$P_{uddd} = \max[120 - 94.77; 0] = 56$	
$P_{dddd} = \max[120 - 65.61; 0] = 79.04$			
Number of paths for each payoff in $t+1$:			
$P_{uuuu} : \binom{4}{4} = 1$		$P_{uuud} : \binom{4}{3} = 4$	
$P_{uudd} : \binom{4}{2} = 6$		$P_{uddd} : \binom{4}{1} = 4$	
$P_{dddd} : \binom{4}{0} = 1$			
Expected value of the put option under the risk-neutral probability measure:			
$E_{\mathbb{Q}}[P_{t+1}] = 1 \cdot 0.53^4 \cdot 0 + 4 \cdot 0.53^3 \cdot 0.47 \cdot 0 + 6 \cdot 0.53^2 \cdot 0.47^2 \cdot 5$			
$+4 \cdot 0.53 \cdot 0.47^3 \cdot 46.40 + 1 \cdot 0.47^4 \cdot 72.90 = 15.38$			
Expected carrying amount in $t+1$:			
$E_{\mathbb{P}}[\mathrm{CA}^*_{t+1}] = 140 - \frac{200}{10} - \frac{15.38}{1.04} \cdot 1.15 = 103$			

process. From the simple example presented here we see that if the possibility of a future write-off is not considered, material distortions in the forecast may arise.

5.4 The Firm's optimal Decision: Earnings Management

5.4.1 The Option to delay Write-Offs

In this section we discuss the more realistic scenario wherein discretion does exist regarding the reporting of the recoverable amount. We will show how the firm (or the firm's manager) will optimally choose in the best interest of the firm's shareholders[18] whether to immediately recognize or delay the write-off if the asset is impaired.

We start our model analysis by stating some assumptions regarding investors' information about the recoverable amount. Primarily, we assume all investors have access to the same information about the current value of RA. This assumption is supported by the fact that empirical studies find that stock prices decrease before write-offs are announced.[19] Nevertheless, we assume that discretion exists with respect to its reporting. In addition, we assume that no discretion exists if the asset is not impaired.

The implementation of earnings management in our setting is straightforward; as depicted in Figure 5.5, the firm has the possibility to immediately recognize the write-off in t as described in section 5.3, or to delay the write-off until the next annual reporting in $t+1$. As opposed to section 5.3, the analysis in this section includes the period $t+1$. The timeline for this section is depicted in Figure 5.6.

Let us first discuss the immediate write-off in t. If the firm immediately recognizes

[18]The assumption of a manager who acts in shareholders' best interests has a long tradition in the real options setting: see, for example, *Myers* (1977). Even though alternative assumptions are used in the well-developed body of research regarding investment decisions and capital structure (see, for example, *Andrikopoulos* (2009) and *Huang*, *Huang* and *Shih* (2012)) we use this simplifying assumption to examine the basic features of the real option to write off.

[19]See, for example, *Elliott* and *Shaw* (1988) and *Alciatore*, *Easton* and *Spear* (2000).

Figure 5.5: The earnings management decision

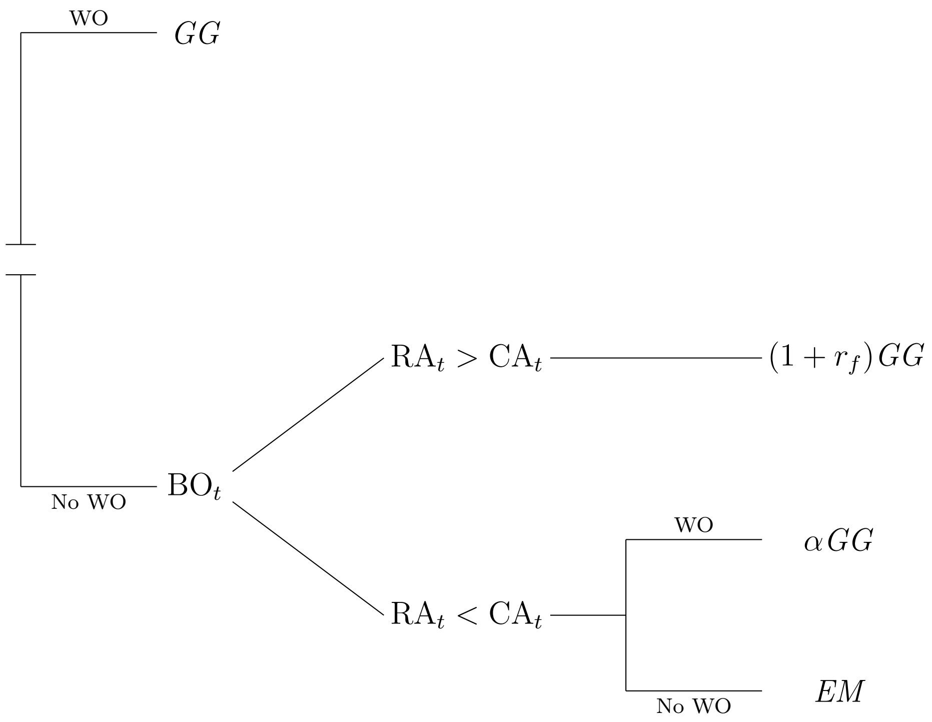
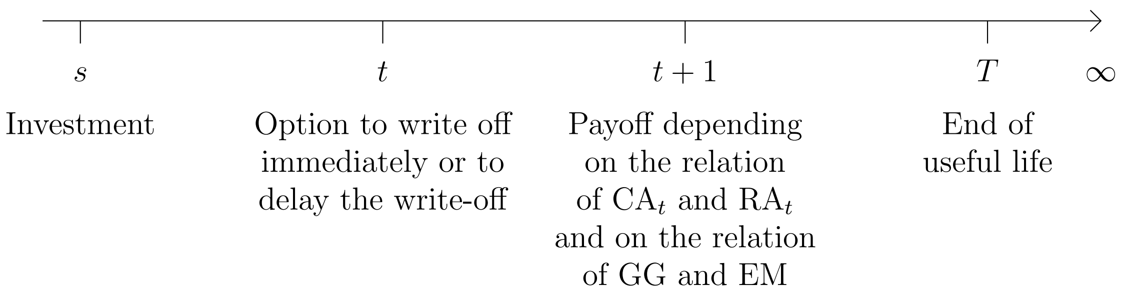


Figure 5.6: Timeline for write-offs with earnings management



the write-off we assume that it realizes a certain payoff of GG as reward for transparent reporting.[20] This reward may result from better relations with suppliers and customers and might, for example, arise if these groups choose their business ties based on the degree of transparency in the reporting of potential business partners. A company with better relations with its suppliers and customers will probably realize lower costs of production and higher margins in asset sales compared to a company with worse relations, which increases the free cash flows and, hence, the firm value.

For the case that the firm delays the write-off until $t+1$ we have to consider two further scenarios, depending on the value of RA. The recoverable amount evolves between t and $t+1$ according to the binomial process given in equation (5.2.2) and as depicted in Figure 5.2. This implies that the value of RA_{t+1} is an uncertain quantity in t. The two scenarios are:

The recoverable amount exceeds the carrying amount ($\mathbf{RA}_{t+1} > \mathbf{CA}_{t+1}$):

A write-off is no longer necessary and the firm realizes a payoff of $(1+r_f)\mathrm{GG}$. This case might occur if the difference in the value has been eroded by depreciation or if the recoverable amount has increased since t. Assuming this payoff assures that the firm is indifferent between the two reporting strategies of immediate write-off and no write-off if it is only temporary. By not recognizing a temporary write-off, the firm has proven itself to be far-sighted. With the information available in $t+1$ the decision to delay the write-off in t is ex-post a correct one. In the long run, a write-off has not been necessary; this anticipation is rewarded by a higher payoff in $t+1$.

[20] We assume that the recognition of the write-off loss itself has no influence on the firm value. This is consistent with the assumption that all market participants are able to estimate the recoverable amount. Under this assumption, a decrease in the recoverable amount can have an influence on the firm value, but the mere reporting of it will not.

The recoverable amount is below the carrying amount ($\mathbf{RA}_{t+1} < \mathbf{CA}_{t+1}$):

A write-off is still necessary. Again, two cases might occur: The firm either decides to catch up on the write-off or to delay the write-off again. If the write-off is recognized then the firm immediately realizes the payoff αGG. This implies that a one-period delay of the write-off is still considered a transparent action by market participants, but there is a certain discount α with $0 \leq \alpha \leq 1$ for the delayed reporting. In the other case the firm realizes a payoff EM(RA), which is defined as a function of the stochastic variable RA. This payoff requires a more detailed analysis.

If the firm has chosen to delay the write-off in t, with the recoverable amount subsequently still being below the carrying amount in $t+1$, and if the firm chooses to further delay the write-off in $t+1$, then we assume that the following payoff is realized:

$$\mathrm{EM(RA)} = \mathrm{EM}^{+} - \mathrm{EM}^{-}(\mathrm{CA}_{t+1} - \mathrm{RA}_{t+1}). \tag{5.4.1}$$

This payoff is composed of two parts since we assume that there are benefits as well as costs associated with earnings management.

The firm receives benefits amounting to EM^{+}. EM^{+} is a positive and certain quantity that reflects the firm- and industry-specific benefits that can be realized from earnings management. Hence, the benefits from earnings management in $t+1$ are a certain quantity from the perspective of t. Benefits from earnings management may, for example, result from reduced interest or from positively influencing the outcome of other contracts that refer to the reported profit. Lower interest could result from, for example, credit agreements that relate interest rates to accounting figures. Another possibility is that credit agreements contain covenants that require immediate redemption if certain accounting figures fall below or rise above a given threshold.

As all market participants are able to estimate the recoverable amount as well as the manager can, they cannot be misled. Rather, they can identify the earnings management and punish the firm for it.

We assume that due to this punishment the firm value is reduced by $\mathrm{EM}^{-}(\mathrm{CA}_{t+1} - \mathrm{RA}_{t+1})$, where EM^{-} is positive and known with certainty. The total costs of earnings management are proportional to the managed amount and hence uncertain from the perspective t. Punishments may include higher interest, worse relations with suppliers or customers or even costs resulting from punishment through enforcement mechanisms.[21]

Taken together, the payoff of the firm if the write-off is delayed in $t+1$ can be described as follows:

$$\mathrm{BO}_{t+1} = \begin{cases} (1+r_f)\mathrm{GG}, & \text{if } \mathrm{RA}_{t+1} > \mathrm{CA}_{t+1}, \\ max(\alpha\mathrm{GG}; \mathrm{EM}), & \text{if } \mathrm{RA}_{t+1} < \mathrm{CA}_{t+1}, \end{cases} \tag{5.4.2}$$

where BO_{t+1} is the payoff in $t+1$. Inserting the definition of the payoff in the case where the firm again delays the write-off in $t+1$ from equation 5.4.1 we can transform this to:

[21]Enforcement mechanisms are usually deployed in principal-agent settings, which we explicitly do not consider here. Additionally we do not install a clear distinction between earnings management within the regulatory range and fraud. Punishment by enforcement mechanisms can by definition occur only in the latter case. We do not want to delve deeper into this theme, but it should still be made clear that the revelation of misstatements will certainly present the firm with material costs.

$$\mathrm{BO}_{t+1} = \begin{cases} (1+r_f)\mathrm{GG}, & \text{if } \mathrm{RA}_{t+1} > \mathrm{CA}_{t+1}, \\ \alpha\mathrm{GG} + \mathrm{EM}^- & \\ \cdot max\left(0; \mathrm{RA}_{t+1} - \left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^+ - \alpha\mathrm{GG}}{\mathrm{EM}^-}\right)\right), & \text{if } \mathrm{RA}_{t+1} < \mathrm{CA}_{t+1}. \end{cases} \tag{5.4.3}$$

This is a barrier option-like payoff which can be interpreted as a down-and-in call. Remember that r_f, CA_{t+1}, GG, EM^+ and EM^- are deterministic and only RA_{t+1} is stochastic. Hence, we have a down-and-in call option with underlying RA and strike $\left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^+ - \alpha\mathrm{GG}}{\mathrm{EM}^-}\right)$, the barrier is CA_{t+1}.

5.4.2 The Value of the Write-Off Option

Pricing of barrier options in discrete time is complicated by the fact that, besides the number of paths that terminate in the money, the number of those paths that additionally cross the barrier has to be determined. Fortunately, closed-form solutions for the valuation of barrier options in discrete time already exist.[22] Nevertheless, there are some special features that have to be taken into account in the considered setting.

As described in section 5.2, an impairment test has to be conducted annually. Each year consists of n periods and the recoverable amount evolves in these periods according to equation 5.2.2. A write-off has to be recognized only if the recoverable amount is below the carrying amount at the time the impairment test is conducted, which is at the end of the year. In contrast to the usual barrier options, the firm will not receive the payoff if the recoverable amount falls below the carrying amount at some point during the year but is above the carrying amount at year-end.

[22]See *Levitan*, *Mitchell* and *Taylor* (2003).

In the context of the valuation of the barrier option this is a simplification. While the order of the up- and down-movements usually has to be considered to identify the number of paths that crossed the barrier during the year, we have to consider the total number of up- and down-movements only. In fact, as we define $d = \frac{1}{u}$, we can rewrite the value of the recoverable amount at the end of the year $\mathrm{RA} \cdot u^k \cdot d^{n-k}$ as $\mathrm{RA} \cdot d^{n-2k} = \mathrm{RA} \cdot d^x$, where x is the net number of down-movements at the end of the year, and this is the only number that we have to consider to ensure that the option is in the money and that the barrier is breached at year-end.

From the Appendix C.1, the pricing formula is given by:

$$
\begin{aligned}
&\text{if } (n-a) \text{ and } (n-b) \text{ are even integers:}\\
&\mathrm{BO}_t = \frac{1}{1+r_f}\left(\sum_{k=\frac{1}{2}(n-a)}^{n}\binom{n}{k}q_u^k q_d^{n-k}(1+r_f)\mathrm{GG} + \sum_{k=\frac{1}{2}(n-b)}^{\frac{1}{2}(n-a)-1}\binom{n}{k}q_u^k q_d^{n-k}\right.\\
&\qquad \cdot\left(\alpha\mathrm{GG} + \mathrm{EM}^-\left(\mathrm{RA}_t d^{n-2k} - \left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^+ - \alpha\mathrm{GG}}{\mathrm{EM}^-}\right)\right)\right)\\
&\qquad \left. + \sum_{k=0}^{\frac{1}{2}(n-b)-1}\binom{n}{k}q_u^k q_d^{n-k}\alpha\mathrm{GG}\right),
\end{aligned}
$$

$$
\begin{aligned}
&\text{if only } (n-a) \text{ is an even integer:}\\
&\mathrm{BO}_t = \frac{1}{1+r_f}\left(\sum_{k=\frac{1}{2}(n-a)}^{n}\binom{n}{k}q_u^k q_d^{n-k}(1+r_f)\mathrm{GG} + \sum_{k=\lceil\frac{1}{2}(n-b)\rceil}^{\frac{1}{2}(n-a)-1}\binom{n}{k}q_u^k q_d^{n-k}\right.\\
&\qquad \cdot\left(\alpha\mathrm{GG} + \mathrm{EM}^-\left(\mathrm{RA}_t d^{n-2k} - \left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^+ - \alpha\mathrm{GG}}{\mathrm{EM}^-}\right)\right)\right)\\
&\qquad \left. + \sum_{k=0}^{\lfloor\frac{1}{2}(n-b)\rfloor}\binom{n}{k}q_u^k q_d^{n-k}\alpha\mathrm{GG}\right),
\end{aligned}
$$

if only $(n-b)$ is an even integer:

$$\mathrm{BO}_t = \frac{1}{1+r_f}\left(\sum_{k=\lceil \frac{1}{2}(n-a) \rceil}^{n} \binom{n}{k} q_u^k q_d^{n-k}(1+r_f)\mathrm{GG} + \sum_{k=\frac{1}{2}(n-b)}^{\lfloor \frac{1}{2}(n-a) \rfloor} \binom{n}{k} q_u^k q_d^{n-k} \right.$$
$$\cdot \left(\alpha\mathrm{GG} + \mathrm{EM}^- \left(\mathrm{RA}_t d^{n-2k} - \left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^+ - \alpha\mathrm{GG}}{\mathrm{EM}^-}\right)\right)\right)$$
$$\left. + \sum_{k=0}^{\frac{1}{2}(n-b)-1} \binom{n}{k} q_u^k q_d^{n-k} \alpha\mathrm{GG} \right),$$

if neither $(n-a)$ nor $(n-b)$ is an even integer:

$$\mathrm{BO}_t = \frac{1}{1+r_f}\left(\sum_{k=\lceil \frac{1}{2}(n-a) \rceil}^{n} \binom{n}{k} q_u^k q_d^{n-k}(1+r_f)\mathrm{GG} + \sum_{k=\lceil \frac{1}{2}(n-b) \rceil}^{\lfloor \frac{1}{2}(n-a) \rfloor} \binom{n}{k} q_u^k q_d^{n-k} \right.$$
$$\cdot \left(\alpha\mathrm{GG} + \mathrm{EM}^- \left(\mathrm{RA}_t d^{n-2k} - \left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^+ - \alpha\mathrm{GG}}{\mathrm{EM}^-}\right)\right)\right)$$
$$\left. + \sum_{k=0}^{\lfloor \frac{1}{2}(n-b) \rfloor} \binom{n}{k} q_u^k q_d^{n-k} \alpha\mathrm{GG} \right),$$

with

$$a = \frac{ln\left(\frac{\mathrm{CA}_{t+1}}{\mathrm{RA}_t}\right)}{\ln d},\; b = \frac{\ln\left(\frac{\left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^+ - \alpha\mathrm{GG}}{\mathrm{EM}^-}\right)}{\mathrm{RA}_t}\right)}{\ln d}.$$

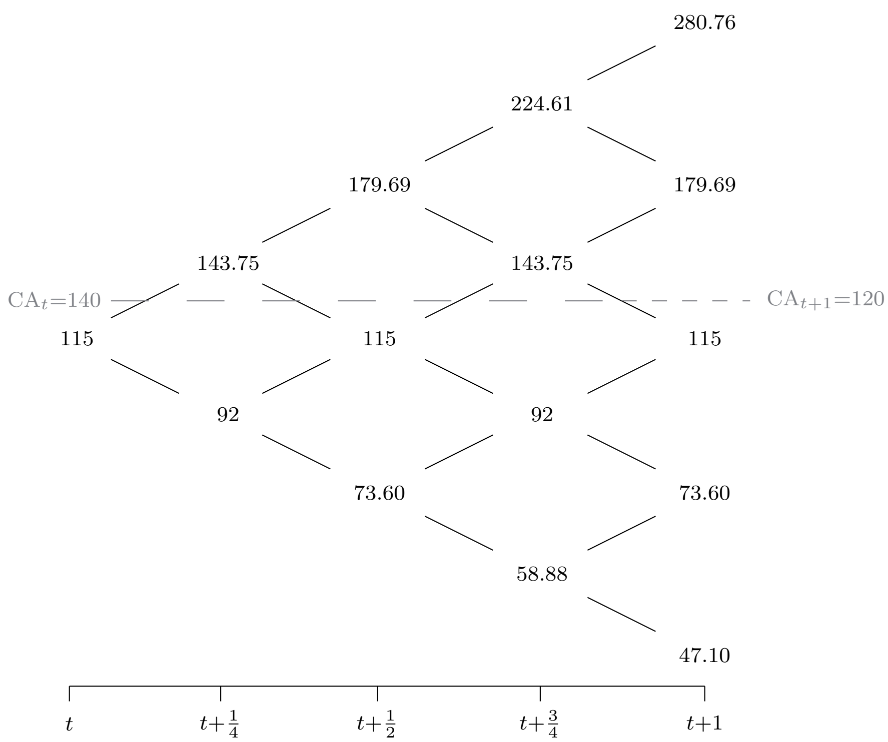
The case differentiation is necessary so as to correctly distinguish the different outcomes and prevent double counting.

The first summation in the pricing formula covers the paths for which the barrier is not breached at the year-end, the second summation reflects those paths in which the barrier is breached and the option to further delay the write-off is in the money, and the third summation contains those paths for which the barrier is breached at the year-end and the option to further delay the write-off is out of the money.

5.4.3 Example with Earnings Management

The setting for this example is equal to the one considered in the example without earnings management in section 5.3.2, but now we introduce reporting discretion. Hence, if the recoverable amount is below the carrying amount at the end of $t+1$, the firm has the option to either further delay the write-off and receive EM or to recognize the write-off and receive αGG. If the recoverable amount is above the carrying amount in $t+1$ the company receives $(1+r_f)$GG. The evolution of RA and the barrier given by CA_{t+1} are depicted in Figure 5.7.

Figure 5.7: Exemplary development of RA



To determine the expected output for each possible state we first have to calculate the borders of x, a and b. The assumed parameters and the calculations are given in Table 5.2.

We see that only if $x = 0$, in the case of two up- and two down-movements, is the recoverable amount below the barrier CA_{t+1} and the option to delay the write-off is in the money. If

Table 5.2: Parameters and calculations: Example with earnings management

Assumed parameters:			
$u = 1.25$	$d = \frac{1}{u} = 0.8$	$r_f = 0.04$	$\text{RA}_t = 115$
$I_s = 200$	$\text{UL} = 10$	$\text{CA}_t = 140$	$\Delta t = \frac{1}{4}$
$n = 4$			
Development of the carrying amount:			
$\text{CA}_{t+1} = 140 - \frac{200}{10} = 120$			
$\mathbb{Q}$-probabilities:			
$q_u = \frac{1+0.04-0.8}{1.25-0.8} = 0.53$		$q_d = \frac{1.25-(1+0.04)}{1.25-0.8} = 0.47$	
Assumed parameters for the payoffs:			
$\text{GG} = 5$	$\alpha = 0.9$	$\text{EM}^+ = 20$	$\text{EM}^- = 2$
Strike price of the option to delay the write-off:			
$\left(120 - \frac{20-0.9\cdot 5}{2}\right) = 112.25$			
Borders for x:			
$a = \frac{\ln\left(\frac{120}{115}\right)}{\ln 0.8} = -0.19$		$b = \frac{\ln\left(\frac{112.25}{115}\right)}{\ln 0.8} = 0.11$	
State-dependent values of the put option in $t+1$:			
$P_{uuuu} = (1+0.4)\cdot 5 = 5.20$		$P_{uuud} = (1+0.4)\cdot 5 = 5.20$	
$P_{uudd} = 0.9\cdot 5 + 2\cdot(115 - 112.25) = 10$			
$P_{uddd} = 0.9\cdot 5 = 4.50$		$P_{dddd} = 0.9\cdot 5 = 4.50$	
Number of paths for each payoff in $t+1$:			
$P_{uuuu} : \binom{4}{\frac{1}{2}(4-(-4))} = 1$		$P_{uuud} : \binom{4}{\frac{1}{2}(4-(-2))} = 4$	
$P_{uudd} : \binom{4}{\frac{1}{2}(4-0)} = 6$			
$P_{uddd} : \binom{4}{\frac{1}{2}(4-2)} = 4$		$P_{dddd} : \binom{4}{\frac{1}{2}(4-4)} = 1$	
Expected value of the barrier option under the risk-neutral probability measure:			
$E_{\mathbb{Q}}[\text{BO}_{t+1}] = 1\cdot 0.53^4\cdot 5.20 + 4\cdot 0.53^3\cdot 0.47\cdot 5.20 + 6\cdot 0.53^2\cdot 0.47^2\cdot 10$			
$+4\cdot 0.53\cdot 0.47^3\cdot 4.50 + 1\cdot 0.47^4\cdot 4.50 = 6.80$			
Value of the barrier option in t:			
$\text{BO}_t = \frac{1}{1+0.04}\cdot 6.80 = 6.54$			

$x > 0$, $\mathrm{RA}_{t+1} > \mathrm{CA}_{t+1}$ and the firm receives $(1 + r_f)\mathrm{GG}$. If $x < 0$, the option is out of the money and the firm receives $\alpha\mathrm{GG}$. The final value of the barrier option amounts to 6.54.

5.4.4 The Decision to delay the Write-Off

We now want to turn our attention to the question of when the firm decides to delay the write-off. We start with the decision in $t + 1$ and subsequently analyze the setting in t.

In $t + 1$ the firm will decide to further delay the write-off whenever $\alpha\mathrm{GG} < \mathrm{EM}$. Using equation 5.4.1 this can be transformed into $\alpha\mathrm{GG} < \mathrm{EM}^+ - \mathrm{EM}^-(\mathrm{CA}_{t+1} - \mathrm{RA}_{t+1})$. If this relation holds, we say that the option is in the money. Remember that as we have a barrier option, the firm will have the opportunity to exercise the option only if $\mathrm{RA}_{t+1} < \mathrm{CA}_{t+1}$. However, if this relation holds, the following is true for the probability that the option to further delay the write-off is exercised:

$$\alpha(-),\ \mathrm{GG}(-),\ \mathrm{EM}^+(+),\ \mathrm{EM}^-(-),\ \mathrm{CA}_{t+1}(-),\ \mathrm{RA}_{t+1}(-). \tag{5.4.4}$$

The intuition behind the fact that the probability of the option exercise decreases in α and GG is that the payoff which the firm receives when the option is not exercised can be interpreted as opportunity costs. These costs increase as α or GG increase. As the probability that the option is exercised decreases in the opportunity costs, it decreases in α and GG. Similarly, as EM^+ increases, the benefit from earnings management increases, which in turn increases the probability that the option is exercised. The costs of further delaying the write-off increase in EM^-, reducing the probability of the option exercise taking place. The same is true for $\mathrm{CA}_{t+1} - \mathrm{RA}_{t+1}$. The costs of earnings management depend on the managed amount. Hence, for the opportunity to exercise the option the difference must be positive, but the probability that the option is exercised is larger the smaller this difference is, this is, the smaller CA_{t+1} and the larger RA_{t+1}.

In t, the firm will decide to delay the write-off whenever $\mathrm{GG} < \mathrm{BO}_t$. For the value of the barrier option BO_t, as given by equation C.1.6, the following is true:

$$r_f(-),\ \alpha(+),\ \mathrm{GG}(+),\ \mathrm{EM}^{+}(+),\ \mathrm{EM}^{-}(-),\ d(+/-),\ \mathrm{CA}_{t+1}(+/-). \tag{5.4.5}$$

It is important to consider that the value of the barrier option comprises the payoffs for all three cases depicted in equation C.1.5, which helps us to make better sense of the signs given in equation 5.4.5. The intuition behind them is as follows: r_f gives the time preference. As r_f increases, payoffs in t are relatively more appreciated than those in $t+1$. As the payoff of the barrier option is received in $t+1$, its value decreases in r_f.

α increases the payoff the firm receives if the barrier is breached but the option is not exercised, and thereby increases the value of the option. GG increases the payoff the firm receives if the barrier is not breached as well as the payoff the firm receives if the barrier is breached but the option is not exercised. Note that GG has no influence on the payoff the firm receives if the option is exercised. Regarding GG, it is important to consider that, even though the value of the barrier option increases with increasing GG, the probability that the firm delays the write-off in t is decreased with increasing GG. This is due to the fact that the opportunity costs (which are given here by GG) increase even more in GG. Because GG does not influence all payoffs and because there is compensation for the time preference only if the barrier is not breached in $t+1$, a one-unit increase in GG will lead to a less than one-unit increase in BO_t, reducing the probability that $\mathrm{GG} < \mathrm{BO}_t$, which is the necessary condition for the firm to delay the write-off in t.

As described above, the probability that the option to further delay the write-off is exercised in $t+1$ increases in EM^{+}. Because the payoff the firm receives if the option is exercised exceeds the payoff the firm receives if the option is not exercised, the value of the barrier option in t increases as the probability that the option to further delay the write-off in $t+1$ increases. Hence, BO_t increases in EM^{+}. Similarly, because an increase in EM^{-} decreases the probability that the option to further delay the write-off in $t+1$ is exercised, the value of the barrier option in t decreases in EM^-.

The changes to BO_t in d and CA_{t+1} are not straightforward to describe. The sensitivity of BO_t with respect to $u = \frac{1}{d}$ is depicted in Figure 5.8. Changes in d change the evolution of RA_{t+1} as well as the $\mathbb{Q}$-probabilities. Due to the change in the $\mathbb{Q}$-probabilities, the value of the barrier has its maximum at $q_u = q_d$ at about $u = 1.3$. If u is decreased and d increased from this point, q_d increases and the probability that the firm receives αGG increases. As $\alpha\mathrm{GG} < (1 + r_f)\mathrm{GG}$, this reduces the option value. The opposite happens if u is increased and d is decreased. At the same time, when q_u or q_d approaches zero, the $\mathbb{Q}$-probabilities for the extreme cases increase but those for the other cases approximate zero, so only one case has material weights. As q_d approaches zero at $q_u = 1 + r_f = 1.04$, the curve steeply decreases to this point (see Figure 5.8). Additionally, if d is increased, the probability that the covenant is breached increases because RA_{t+1} is lower, which results in additional paths in which the option is exercised, increasing the option value. This case is not depicted in Figure 5.8, because with the given parameters $u < 1 + r_f$ would be necessary, which leads to a negative q_d.

The sensitivity of BO_t with respect to CA_{t+1} is presented in Figure 5.9. As discussed above, the option to further delay the write-off in $t + 1$ will be exercised only if $\mathrm{RA}_{t+1} < \mathrm{CA}_{t+1}$. However, the higher the carrying amount the lower the probability that the barrier is not breached, resulting in a payoff of $(1+r_f)$GG, which is higher than the payoff the firm receives if the barrier is breached and the option is not exercised, i.e. αGG. This is why the flatter part of the curve depicted in Figure 5.9 decreases with increasing CA_{t+1}. The peaks result from the fact that the strike increases in CA_{t+1}, with the consequence that whenever the carrying amount is just above the recoverable amount at one path, the value of the option is high because the barrier is breached for this outcome and the strike is relatively low. With increasing carrying amount the strike increases until the option is not exercised anymore. Notice that the peaks coincide with the outcomes for RA_{t+1} as depicted in Figure 5.7.

There are some practical implications that can be deduced from our findings. The values of r_f, d and CA_{t+1} cannot be affected externally in most cases. However, the values of α, GG,

Figure 5.8: Sensitivity with respect to u

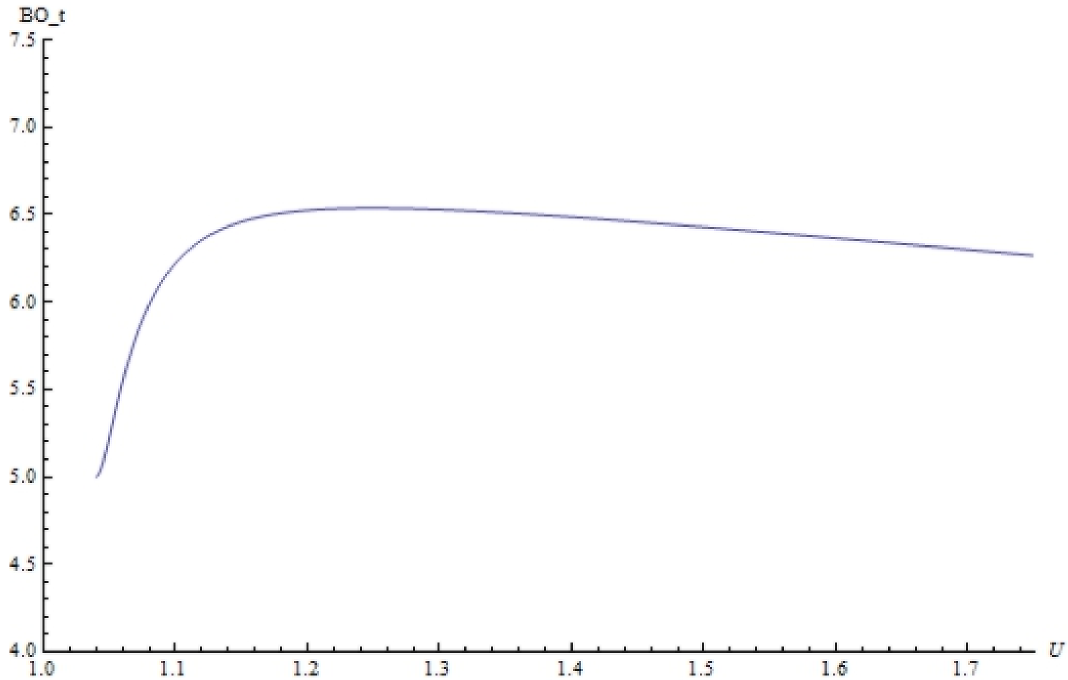
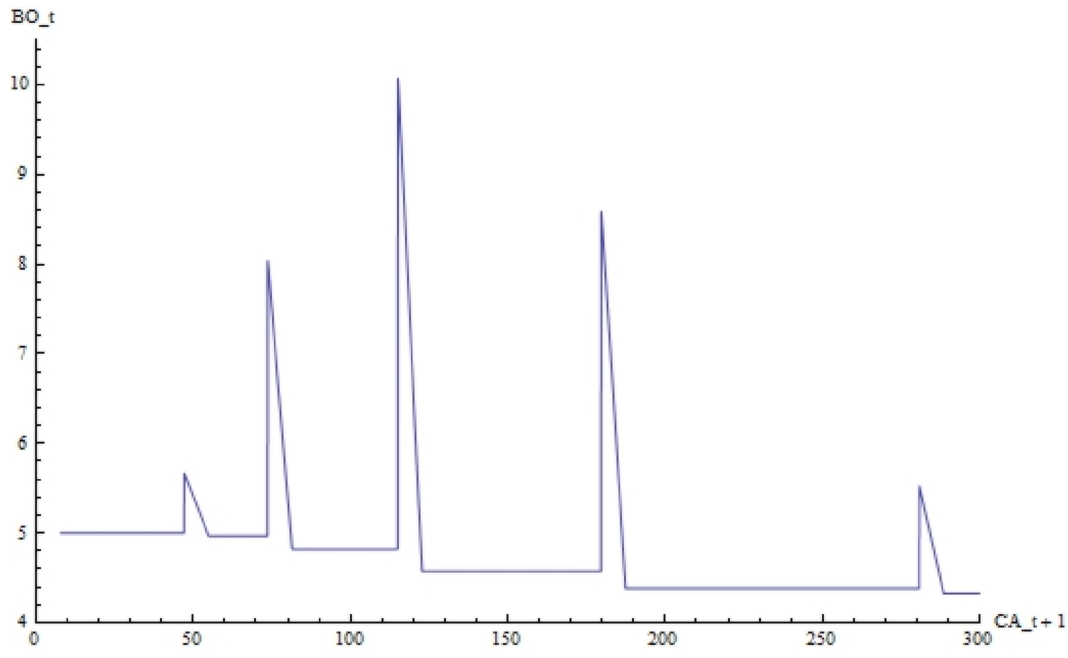


Figure 5.9: Sensitivity with respect to CA_{t+1}



EM^+, and EM^- can. These values reflect how capital market participants react to earnings management and transparent reporting. Considering the findings reported above, we see that it is the costs and benefits of earnings management that are the most effective parameters to prevent earnings management in the write-off decision. Because the benefits from transparent reporting have a positive influence on the value of delaying the write-off, they have less influence on the probability that write-offs are delayed at the first stage. The existence of benefits from earnings management crucially depends on contractual outcomes that refer to accounting numbers. The costs of earnings management can be increased by implementing punishment mechanisms. Therefore, with the implementation of powerful enforcement mechanisms, a good step in this direction has already been taken.

5.5 Summary

In this paper we provide a theoretical approach to the question of when earnings management regarding the writing off of fixed assets is optimal. More specifically, we analyze the conditions under which a write-off will be opportunistically delayed and when it is immediately recognized and transparent reporting is guaranteed. While earnings management regarding the write-off decision is frequently analyzed empirically, a theoretical framework does not yet exist.

In our analysis, we apply a simplified real options setting to study the determinants of the write-off decision. We first examine a setting in which no reporting discretion exists and each write-off is immediately recognized. We find that the possibility of future write-offs reduces the expected carrying amount by the value of a put option with the recoverable amount as the underlying and the carrying amount as the strike price. Subsequently, we analyze a setting in which reporting discretion exists in a way that allows the firm to delay the write-off in t and again in $t+1$. In this setting, the payoff in $t+1$ can be interpreted as the payoff of a barrier option, particularly a down-and-in call. The firm will only delay the write-off in t if the value of the barrier option exceeds the payoff that results from immediate recognition of the write-off. We provide sensitivity analyses for the determinants of the decision to delay the write-off in each period.

While those determinants that describe the evolution of the carrying amount and the recoverable amount cannot be influenced externally, those that describe the payoffs in all states can. The payoff the firm receives for transparent reporting is influenced by the assessment of transparency by market participants and the importance ascribed to it. Similarly, the payoff the firm receives for earnings management is influenced by the amount of (contractual) outcomes that can be influenced by earnings management and by the existence and efficiency of punishment mechanisms. Hence, our results should be of interest to market participants, standard setters and enforcement institutions alike, as it is a first step on the way to reducing earnings management in the write-off decision.

The model developed here has the potential for several extensions. From the real options point of view, the analysis could be transferred to a continuous time setting, the perpetuity of the option to delay the write-off could be incorporated and a number of further options to manage earnings using the write-off decision and the respective size could be included. From an accounting point of view, revaluations could be considered and the payoffs could be defined differently. A further interesting extension would be to introduce an agency conflict between the manager and the shareholders of the company by introducing a performance-based compensation system as *Huang*, *Huang* and *Shih* (2012) did for the analysis of the optimal investment and financing decision. Furthermore, the setting developed here is not limited to the analysis of write-offs but could be used to analyze other, more general settings for earnings management.

Appendix C

C.1 Derivation of the pricing formula for the down-and-in call

We consider a down-and-in call with maturity $t+1$, where the period $[t; t+1]$ is divided into n subperiods of equal length. RA is the underlying, $\left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^{+} - \alpha\mathrm{GG}}{\mathrm{EM}^{-}}\right)$ the strike price and CA_{t+1} the barrier. For the analysis of a down-and-in call at time t, $\mathrm{RA}_t > \mathrm{CA}_{t+1}$ is valid. RA evolves according to equation 5.2.2. The value of RA at time $t+1$ is $\mathrm{RA}_{t+1} = \mathrm{RA}_t u^k d^{n-k}$, where k is the number of up-movements. As $d = \frac{1}{u}$ we can write $\mathrm{RA}_{t+1} = \mathrm{RA}_t d^{n-2k} = \mathrm{RA}_t d^x$ where $x = n - 2k$ denotes the net number of down-movements. If the barrier is breached at the end of the year, the firm receives the payoff $\alpha\mathrm{GG} + \mathrm{EM}^{-} \cdot max\left(0; \mathrm{RA}_{t+1} - \left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^{+} - \alpha\mathrm{GG}}{\mathrm{EM}^{-}}\right)\right)$. If the barrier is not breached at the end of the year, the firm receives the payoff $(1 + r_f)\mathrm{GG}$.

In the case considered here, the barrier is only breached if it is really crossed and not simply touched. The minimum net number of down-movements a at the end of the year for $\mathrm{RA}_{t+1} < \mathrm{CA}_{t+1}$ is as follows:

$$\begin{aligned} \mathrm{RA}_t d^x &< \mathrm{CA}_{t+1} \\ x &> \frac{ln\left(\frac{\mathrm{CA}_{t+1}}{\mathrm{RA}_t}\right)}{\ln d} = a. \end{aligned} \tag{C.1.1}$$

For the option to still terminate in the money $\mathrm{RA}_{t+1} \geq \left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^{+} - \alpha\mathrm{GG}}{\mathrm{EM}^{-}}\right)$ has to hold. For the maximum net number of down-movements b it follows that:

$$
\begin{aligned}
\mathrm{RA}_t d^x &\geq \left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^+ - \alpha\mathrm{GG}}{\mathrm{EM}^-}\right) \\
x &\leq \frac{\ln\left(\frac{\left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^+ - \alpha\mathrm{GG}}{\mathrm{EM}^-}\right)}{\mathrm{RA}_t}\right)}{\ln d} = b.
\end{aligned} \tag{C.1.2}
$$

Remember that all parameters of a and b are known in t.

The pricing equation used to value a plain vanilla call is given by:

$$
\mathrm{C}_t = \frac{1}{1+r_f} \sum_{k=0}^{n} \binom{n}{k} q_u^k q_d^{n-k} \cdot \max(0; \mathrm{S}_{t-1} u^k d^{n-k} - \mathrm{K}), \tag{C.1.3}
$$

where C_t is the price of the call in t, S_{t-1} is the value of the underlying in $t-1$ and K is the strike price. If a barrier option is considered, the holder will not receive the payoff of the maximum function in all cases, but only in those cases in which the barrier has been crossed. In our special case the firm will receive the payoff specified in equation 5.4.3 as the second case only if the recoverable amount is below the carrying amount at the end of the year; otherwise, it will receive $(1+r_f)\mathrm{GG}$. Considering the boundaries for x derived above, this results in the following payoff of the barrier option in $t+1$:

$$
\mathrm{BO}_{t+1} = \begin{cases} (1+r_f)\mathrm{GG}, & \text{if } x \leq a, \\ \alpha\mathrm{GG} + \mathrm{EM}^- \left(\mathrm{RA}_{t+1} - \left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^+ - \alpha\mathrm{GG}}{\mathrm{EM}^-}\right)\right), & \text{if } a < x \leq b, \\ \alpha\mathrm{GG}, & \text{if } x > b. \end{cases} \tag{C.1.4}
$$

Because $x = n - 2k$ evolves in steps of two, we cannot use it as index for the summation. Hence, we have to calculate the boundaries for the number of up-movements, k. From $x = n - 2k$ and $a < x \leq b$ it follows that $\frac{1}{2}(n-b) \leq k < \frac{1}{2}(n-a)$ has to hold for the barrier to be breached and the option to terminate in the money. Expressing the boundaries as a function of k, we get:

$$\mathrm{BO}_{t+1} = \begin{cases} (1+r_f)\mathrm{GG}, & \text{if } k \geq \frac{1}{2}(n-a), \\ \begin{array}{l} \alpha\mathrm{GG} + \mathrm{EM}^- \left(\mathrm{RA}_{t+1}\right. \\ \left. - \left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^+ - \alpha\mathrm{GG}}{\mathrm{EM}^-}\right)\right) \end{array}, & \text{if } \frac{1}{2}(n-b) \leq k < \frac{1}{2}(n-a), \\ \alpha\mathrm{GG}, & \text{if } k < \frac{1}{2}(n-b). \end{cases} \tag{C.1.5}$$

For the pricing equation, a case differentiation is necessary to correctly distinguish the different payoffs. For those cases in which $(n-a)$ or $(n-b)$ is an even integer, the boundaries have to be chosen manually. In all other cases we can use the ceiling and the floor functions:

if $(n-a)$ and $(n-b)$ are even integers:

$$\begin{aligned} \mathrm{BO}_t = \frac{1}{1+r_f} \Bigg(& \sum_{k=\frac{1}{2}(n-a)}^{n} \binom{n}{k} q_u^k q_d^{n-k} (1+r_f)\mathrm{GG} + \sum_{k=\frac{1}{2}(n-b)}^{\frac{1}{2}(n-a)-1} \binom{n}{k} q_u^k q_d^{n-k} \\ & \cdot \left(\alpha\mathrm{GG} + \mathrm{EM}^- \left(\mathrm{RA}_t d^{n-2k} - \left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^+ - \alpha\mathrm{GG}}{\mathrm{EM}^-} \right) \right) \right) \\ & + \sum_{k=0}^{\frac{1}{2}(n-b)-1} \binom{n}{k} q_u^k q_d^{n-k} \alpha\mathrm{GG} \Bigg), \end{aligned}$$

if only $(n-a)$ is an even integer:

$$\begin{aligned} \mathrm{BO}_t = \frac{1}{1+r_f} \Bigg(& \sum_{k=\frac{1}{2}(n-a)}^{n} \binom{n}{k} q_u^k q_d^{n-k} (1+r_f)\mathrm{GG} + \sum_{k=\lceil \frac{1}{2}(n-b) \rceil}^{\frac{1}{2}(n-a)-1} \binom{n}{k} q_u^k q_d^{n-k} \\ & \cdot \left(\alpha\mathrm{GG} + \mathrm{EM}^- \left(\mathrm{RA}_t d^{n-2k} - \left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^+ - \alpha\mathrm{GG}}{\mathrm{EM}^-} \right) \right) \right) \\ & + \sum_{k=0}^{\lfloor \frac{1}{2}(n-b) \rfloor} \binom{n}{k} q_u^k q_d^{n-k} \alpha\mathrm{GG} \Bigg), \end{aligned}$$

if only $(n-b)$ is an even integer:

$$
\begin{aligned}
\mathrm{BO}_t = \frac{1}{1+r_f} \Bigg(& \sum_{k=\lceil \frac{1}{2}(n-a) \rceil}^{n} \binom{n}{k} q_u^k q_d^{n-k} (1+r_f)\mathrm{GG} + \sum_{k=\frac{1}{2}(n-b)}^{\lfloor \frac{1}{2}(n-a) \rfloor} \binom{n}{k} q_u^k q_d^{n-k} \\
& \cdot \left(\alpha\mathrm{GG} + \mathrm{EM}^- \left(\mathrm{RA}_t d^{n-2k} - \left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^+ - \alpha\mathrm{GG}}{\mathrm{EM}^-} \right) \right) \right) \\
& + \sum_{k=0}^{\frac{1}{2}(n-b)-1} \binom{n}{k} q_u^k q_d^{n-k} \alpha\mathrm{GG} \Bigg),
\end{aligned}
\tag{C.1.6}
$$

if neither $(n-a)$ nor $(n-b)$ is an even integer:

$$
\begin{aligned}
\mathrm{BO}_t = \frac{1}{1+r_f} \Bigg(& \sum_{k=\lceil \frac{1}{2}(n-a) \rceil}^{n} \binom{n}{k} q_u^k q_d^{n-k} (1+r_f)\mathrm{GG} + \sum_{k=\lceil \frac{1}{2}(n-b) \rceil}^{\lfloor \frac{1}{2}(n-a) \rfloor} \binom{n}{k} q_u^k q_d^{n-k} \\
& \cdot \left(\alpha\mathrm{GG} + \mathrm{EM}^- \left(\mathrm{RA}_t d^{n-2k} - \left(\mathrm{CA}_{t+1} - \frac{\mathrm{EM}^+ - \alpha\mathrm{GG}}{\mathrm{EM}^-} \right) \right) \right) \\
& + \sum_{k=0}^{\lfloor \frac{1}{2}(n-b) \rfloor} \binom{n}{k} q_u^k q_d^{n-k} \alpha\mathrm{GG} \Bigg).
\end{aligned}
$$

As if $(n-a)$ is even, $\frac{1}{2}(n-a) = \lfloor \frac{1}{2}(n-a) \rfloor = \lceil \frac{1}{2}(n-a) \rceil$ and if $(n-b)$ is even, $\frac{1}{2}(n-b) = \lfloor \frac{1}{2}(n-b) \rfloor = \lceil \frac{1}{2}(n-b) \rceil$, using only the floor and ceiling functions would lead to double counting whenever $(n-a)$ or $(n-b)$ is an even integer. As n, a and b are known in t, the relevant case can therefore easily be chosen.

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